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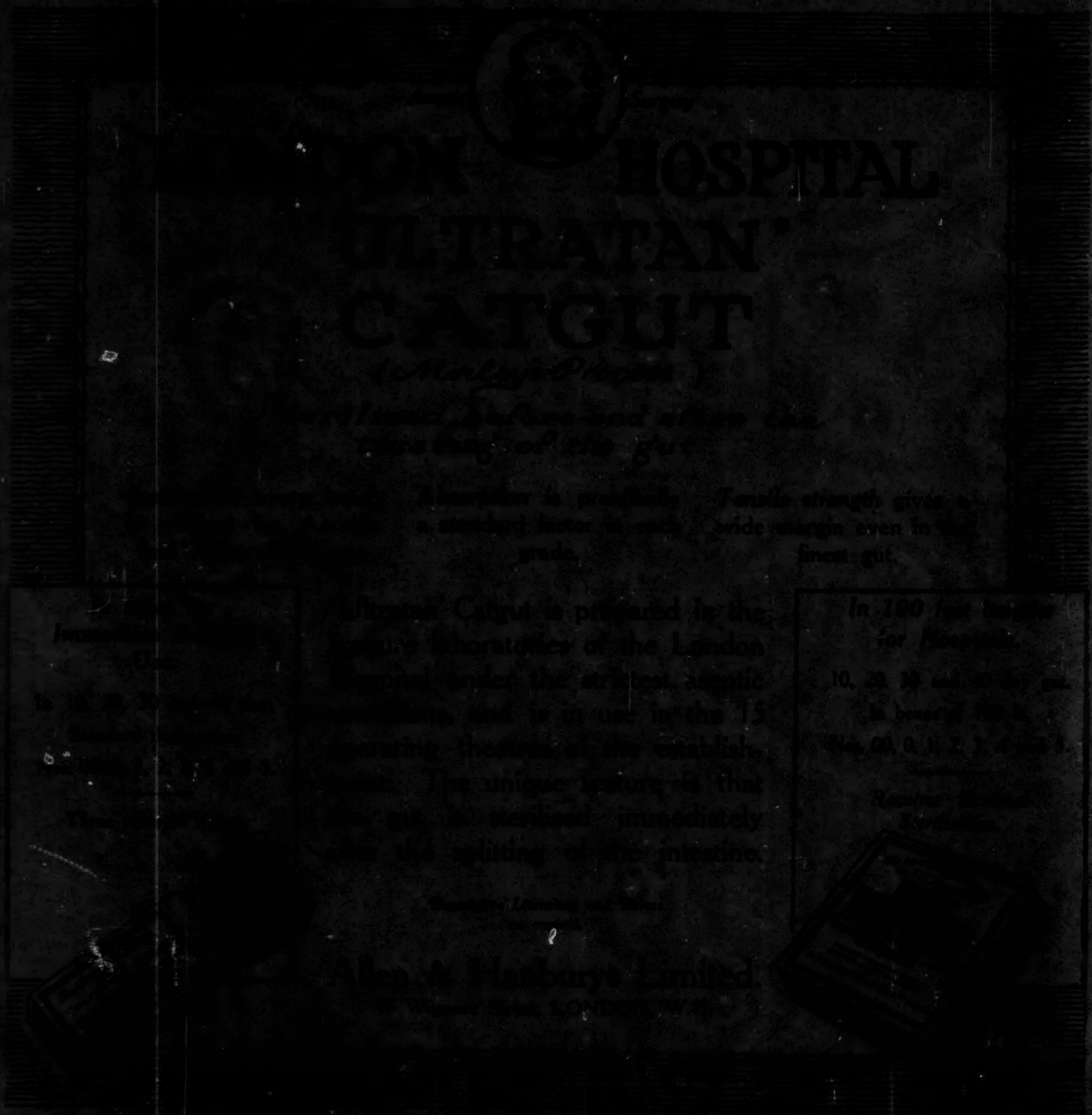

HOSPITAL
ULTRATAN
CATGUT

SIR CHARLES BELL, K.G.H.

1774–1842.

Sir Charles Bell, physiologist, surgeon, artist, critic, and anatomist, was born in November, 1774, the youngest of the six children of an old Jacobite minister of the Episcopal Church of Scotland who had married a granddaughter of Bishop White, Primus of Scotland. His father's cure at Doun in Menteath was worth twenty-five pounds a year, and the family circumstances were so straitened that the schooling of an elder brother could not be continued after he was eleven years old, although the fees only amounted to five shillings a quarter. Yet, in spite of this, two brothers were educated for the law and two entered the medical profession, and three of the four qualified for admission to the Dictionary of National Biography. The old minister died in 1779, and Charles owed his early education to his mother. From her he inherited the refined taste, the skilful pencil, and the artistic temperament which added so much to his enjoyment of life whilst it militated against his success as an operating surgeon; for he hated to give pain, and there were no anæsthetics.

The family was singularly united and, as one after another rose in the world, each did his best to help the rest. Between Charles Bell and his brother George Joseph, his senior by four years—who afterwards became Professor of Scots Law in the University of Edinburgh—there was a lifelong and almost daily interchange of letters showing the deepest affection on both sides. Charles passed without distinction through the High School at Edinburgh, and was then taken in hand by John Bell, his brother, nine years older than himself. John Bell had already become a surgeon and teacher of surgery of some eminence in Edinburgh, and the two brothers soon published an *Anatomy of the Human Body* in four volumes. It became a standard work, ran through several editions, and was translated into German. Like other works published by the two brothers between 1797 and 1804, it is illustrated with excellent etchings and engravings made from drawings by Charles Bell. About the year 1800 arose the 'Dawplucker' controversy, one of those professional quarrels conducted with bitter personalities which were not unusual in London, Dublin, and Edinburgh at this period. In this particular case it raged between Professor Gregory and John Bell, and resulted in the exclusion of Bell from the Royal Infirmary, the retirement of Charles to London, and the subsequent censure of Gregory by the College of Physicians for his 'perversion of the truth'.

Bell arrived in London in November, 1804, with a slenderly-lined purse and without introductions. He had, however, already made his name as a teacher of surgery; he was acquainted with Longman, who had published his books, and he was known directly or indirectly to men like Brougham, Horner, and Jeffrey, who had all been educated at the High School and were struggling to make their names in London.

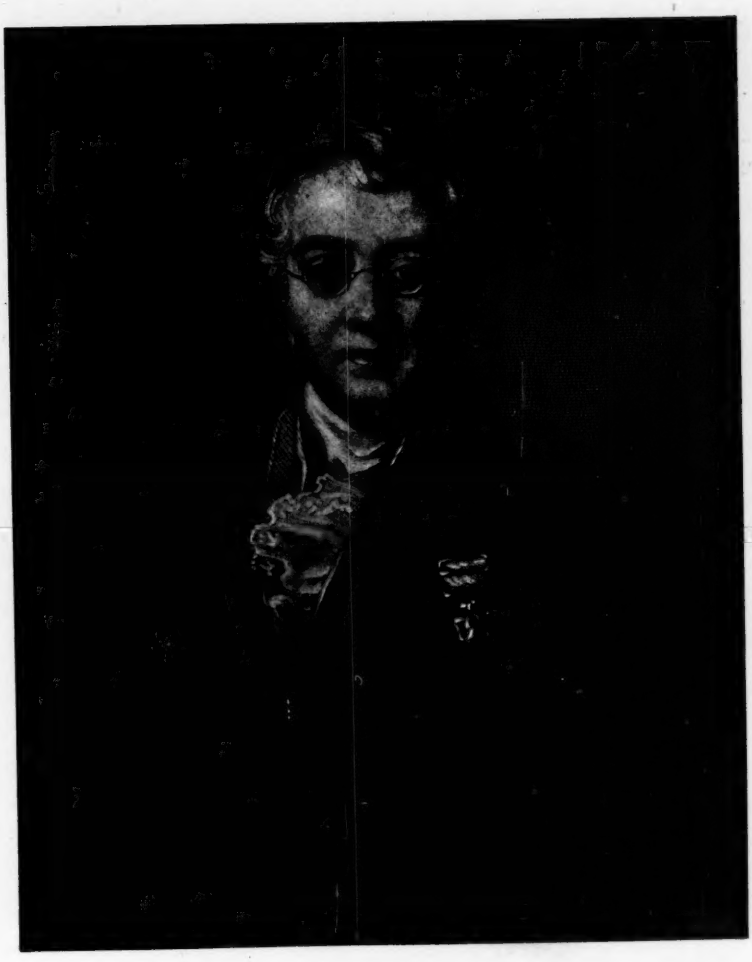
Bell took lodgings at 10, Fludyer Street, Westminster, and called upon the leading men of the profession, Sir William Blizard, Abernethy, Lynn, Dr. Maton, Wilson who carried on the Great Windmill Street School of Medicine, and even Sir Joseph Banks. He was always well received, as a young man of talent with pleasant manners and ready to work. For a year he remained in his lodgings, turning his anatomical knowledge to account by teaching artists, drawing from the life at the Royal Academy school, and completing the book on *The Anatomy of Expression* which he had brought with him from Edinburgh. In September, 1805, he rented with much trepidation a dilapidated house in Leicester Street, Leicester Square, which had formerly belonged to Speaker Onslow. Taking a builder with him, his fears were not lessened by the report that the roof alone would want "hundreds spending upon it" and that he had "better have nine bastard children than

this house over your head". The report was evidently exaggerated, for he obtained an estimate and found a man who undertook to put it in complete repair for £20 and keep it so for £3 a year. He borrowed the necessary money of his brother, took possession, and immediately began to lecture in it upon surgery and anatomy. Professor William Gibson, of the University of Philadelphia, who was one of his pupils, tells a good ghost story of the house in his *Rambles in Europe*, published in 1841.

Bell worked diligently, lecturing for an hour and a half, usually twice and sometimes three times a day, but pupils came slowly and patients more slowly still, so that he often got disheartened.

In 1807 he occupied himself with some speculations on a New Anatomy of the Brain, but his ideas received little encouragement, though they contained the germ which afterwards made his name famous as a physiological anatomist. In this year, too, he published a work on the treatment of strictures. In 1809 he made a journey to Portsmouth and visited the wounded who had just arrived at Haslar after the battle of Corunna; by so doing he gained a knowledge of gunshot wounds which proved of the utmost value in 1815, when he went to Brussels immediately after the battle of Waterloo and rendered good service to the wounded French prisoners. In 1811 he put together his speculations on the New Anatomy of the Brain, which had occupied his attention for many years, and published it in the form of a letter which was privately printed. It fell dead, but was afterwards useful in establishing his claim to priority. In this year he married Marion Shaw, a sister of his brother George's wife and of his two favourite pupils, John and Alexander Shaw. The marriage was one of the greatest happiness, although there were no children; his wife, though delicate at first, long outlived him and died at the age of 80. She brought him a small dowry, which was spent in acquiring a share in the Hunterian School of Medicine in Great Windmill Street. In April, 1814, he was elected Surgeon to the Middlesex Hospital by a majority of 265 votes in a poll of 473. Comparing the state of the hospital when he entered with that in which he left it on retiring a quarter of a century later, he says: "At this time a third part of the old hospital was an asylum for poor Frenchmen, and John Shaw was the only dresser; in 1836 the hospital has been enlarged with additional wings, the wards are full, and there is £120,000 standing to its credit in the Funds". Bell soon attracted students to his lectures, and proved himself an excellent operator. His horror of giving pain, however, made the operations nearly as painful to himself as to the patient, and he envied those who, like Astley Cooper, were able to pursue the even tenor of their way, doing their best for the patient and not greatly regarding the issue. Yet, in spite of this infirmity, he remained operating in Brussels after the battle of Waterloo from six in the morning until seven at night on three successive days. In 1821 he communicated his matured discoveries on the nervous system to the Royal Society, and in 1824 he was elected Professor of Anatomy and Surgery at the College of Surgeons. His lectures were well received by a highly critical audience, and the substance of them was afterwards published by the Society for the Diffusion of Useful Knowledge under the title of *Animal Mechanics*. On the accession of William IV he was made a Knight of the Guelphic Order of Hanover, the honour being at the same time conferred upon Herschel, Ivory, Leslie, and David Brewster. On the foundation of the London University, Bell was nominated the first Professor of Physiology, but he was soon dissatisfied with the University management, and resigned. Some premonition of failing health caused him to resign his position in London in 1836. He returned to Edinburgh, and was appointed Professor of Surgery in the University. Here he devoted all his spare time to fly fishing, a recreation which he had acquired in London and carried out at Chenies, Latimers, and Burford Bridge. He suffered from attacks of angina pectoris, and died in one of them on May 27, 1842, whilst on a visit to some friends at Hallow Park, near Worcester.

Bell has many claims to remembrance. 'Bell's Palsy' and the 'External Respiratory Nerve of Bell' recall his researches on the nervous system; *The Anatomy of Expression* and his *Treatise on the Hand* may still be read with profit; the drawings from his own pencil which illustrate his books are often delightful; whilst his letters give pictures of a bygone life in London which are of the utmost interest.



Charles Bell

On the physiological side he taught that the cerebrum and cerebellum are as different in function as in form; that the nerves are not single nerves possessing various powers, but are bundles of different fibres which are as distinct in their office as they are in their origin from the brain; that the nerves of sense, the nerves of motion, and the vital nerves are separate throughout their whole course, though they seem sometimes united in one bundle; and that they depend for their attributes on the organs of the brain to which they are severally attached. In regard to the nerves, too, he demonstrated for the first time that the nerves of motion are distinct from the nerves of sensation. Hitherto the only attempts made to distinguish their uses had been by performing experiments on the trunks of nerves at a distance from their origins. Bell examined the nerves at their roots and, by experiments on the living animal, learnt the functions of the anterior and posterior roots of the spinal nerves. He also had some idea of specialized tracts in the spinal cord. He thus prepared the ground which was successfully cultivated by later physiologists.

Of *The Anatomy of Expression* Charles Darwin, in his book on the *Expression of the Emotions in Man and Animals*, writes that "Sir Charles Bell may with justice be said not only to have laid the foundations of the subject as a branch of science, but to have built up a noble structure. His work is in every way very deeply interesting; it includes graphic descriptions of the various emotions, and is admirably illustrated. It is generally admitted that his service consists chiefly in having shown the intimate relation which exists between the movements of expression and those of respiration". Here again, Bell was the pioneer; but in this work as well as in his Bridgewater treatise on 'The Hand' he was hampered by teleology, for as yet there was no theory of evolution.

Here is a picture of Abernethy and the outskirts of London as Bell knew it in 1807. Writing to his brother in September, he says: "Yesterday I took my first ride with Abernethy. We went over Highgate Hill and down on the other side towards Finchley, came round through the most enchanting bye-roads to Enfield, dined at Southgate, and rode home in the afternoon. My companion is quite a peculiar creature, but I believe the infection of my delight made him unusually free and frisky; and strange to say, in all our ride we met nobody. I gave my companion much credit for the choice of roads, and was not a little astonished to find the principle which guided him thus announced on coming into town thro' the last (turnpike) gate. 'There,' says he, 'I'll venture to say there is not another man who will take you a ride of twenty miles round London for three halfpence.' His avoiding tolls took me through these very roads I delight in". Now, alas, a weary waste of suburban houses and tramlines!

Dr. Eugene R. Corson drew renewed attention a few years ago to the artistic qualities shown by Sir Charles Bell in he water-colour sketches which he made for the use of the engravers and etchers employed to illustrate his various works. Many of these sketches are preserved—some at the Middlesex Hospital, some at the Royal Army Medical College, Millbank, some in the Surgeon-General's Library at Washington, and a few at the Royal College of Surgeons of England.

The portrait is reproduced from a steel engraving published in Pettigrew's Medical Portrait Gallery.

CARCINOMA OF THE APPENDIX CAUSING DIVERTICULA OF THE APPENDIX AND ACUTE APPENDICULAR OBSTRUCTION.

By D. P. D. WILKIE, Edinburgh.

Primary carcinoma of the appendix is now a well-recognized pathological entity, and the literature contains records of between two and three hundred cases. In the majority, the discovery of the growth has been more or less accidental in the routine examination of appendices removed at operation or post mortem, and for the most part the presence

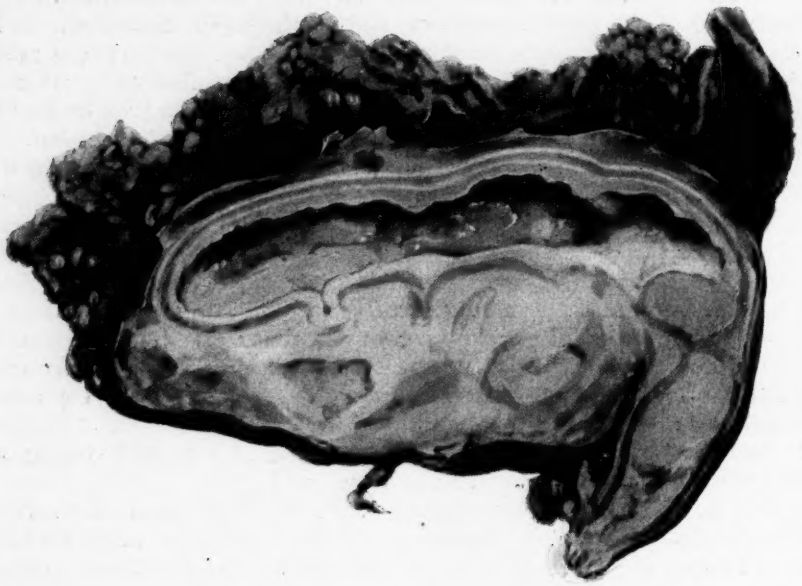


Fig. 242.—Note yellow growth occluding lumen near proximal end, empyema beyond, and diverticulum on mesenteric border near tip.

of the tumour has appeared to be more of the nature of a secondary degeneration than the primary cause of the symptoms of which the patient may have complained.

The following three cases which I have met with in the course of eighteen months are of interest chiefly because in each the presence of the growth in the appendix obstructing its lumen led to very definite acute symptoms which called for operation. Before taking up the special points in pathology which were shown by these cases, the following short clinical notes are given :—

Case 1.—S. W., female, age 15, admitted to hospital June 19, 1918.

Diagnosis.—Acute appendicitis.

History.—Five days before admission, patient was suddenly seized with acute abdominal pain while at her work. She had to stop work and go home to bed. The pain continued intermittently for twenty-four hours and then subsided ; but commenced again on the following day, and for the three days before admission she was never free from pain. Vomiting started two days before admission, and continued at intervals up till the time of operation. The bowels had been very constipated for some weeks.

FIG 243.—Low-power view of growth in *Case* 1; spheroidal-celled type of tumour. ×48.

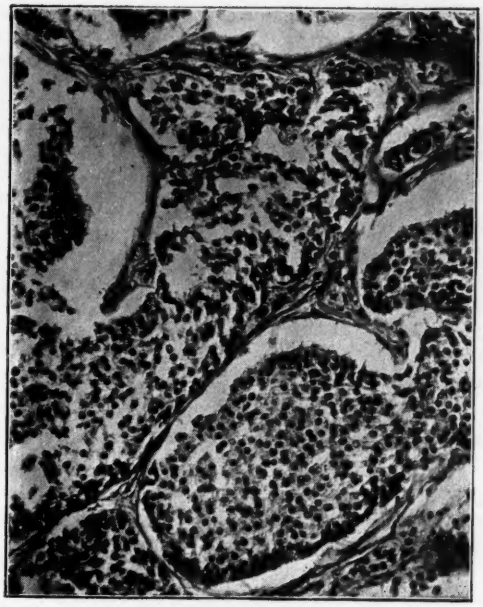


FIG. 244.—High-power view of growth in *Case* 1. ×160.

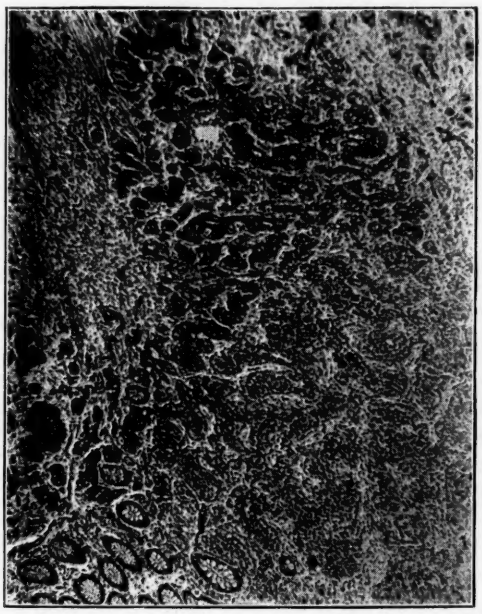


FIG. 245.—Low-power view showing portion of growth with normal mucosa at one corner from *Case* 2. ×48.

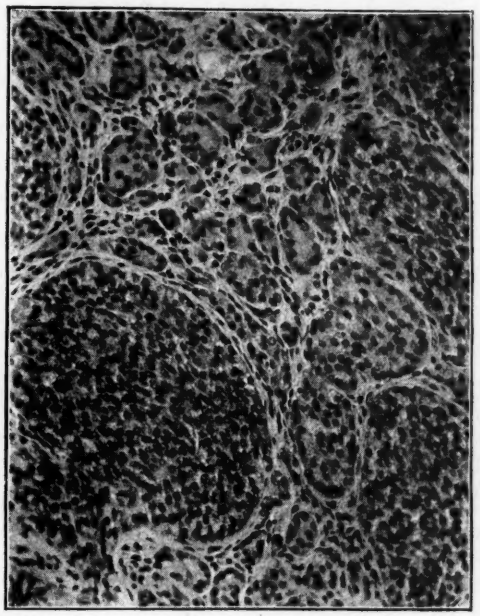


FIG. 246.—High-power view of tumour in *Case* 2. ×160.

ON EXAMINATION.—The child looked ill. Temperature 100°, pulse 104. There was marked rigidity of the whole of the right side of the abdomen, cutaneous hyperæsthesia over the right rectus muscle both above and below the umbilicus, and definite palpable resistance in the right lumbar and iliac regions.

OPERATION.—Gridiron incision in right iliac region. Extraperitoneal tissues very œdematous. On opening the peritoneum a firm mass was exposed, covered with omentum and lying external to the cæcum and ascending colon. The omental adhesions were clamped and cut, the base of the appendix exposed and divided, and the large mass peeled off the outer side of the cæcum and ascending colon. A small abscess between the appendix and ascending colon had made its way partially through the wall of the latter. After swabbing away the pus the wall of the colon was repaired with Lembert sutures. A rubber-dam drain was left in along the outer wall of the ascending colon. The patient made a prompt recovery.

The appendix was of unusual size and, on dividing the mass longitudinally, it was seen to be made up of an empyema of the appendix distal to a typical yellow-coloured growth in the proximal half of the organ (*see Fig.* 242). A large part of the mass was made up of greatly thickened and indurated meso-appendix. Sections of the growth proved it to be a spheroidal-celled carcinoma. Sections of the meso-appendix showed no involvement by tumour growth. Several diverticula projecting from the mesenteric border of the appendix indicated that the obstruction of the appendix had been a gradually increasing factor before the final and complete obstruction led to the acute symptoms.

Case 2.—A. J. G., male, age 22, admitted Feb. 9, 1920. Two days before admission the patient was seized with pain across the lower part of the abdomen. The pain was spasmodic in character and continued off and on throughout the night; the following day it was more severe, and was not relieved by hot fomentations. At 4 a.m. on the next day he had very severe spasms of pain. When seen in consultation with his doctor at 10 a.m., he looked ill; his temperature was 101°, pulse 104. There was definite hyperæsthesia and tenderness in the right iliac region, and marked boarding of the muscles on the right side of the abdomen. He was removed to hospital and operated on at once. He gave no history of any previous attacks, and had been in good health before this attack began.

FIG. 247.—Yellow growth obstructing lumen near proximal end of appendix. Concretions beyond. Note numerous diverticula at mesenteric border.

OPERATION.—Gridiron incision. The extraperitoneal tissues were œdematous. A greatly engorged and distended appendix covered with lymph was found lying under the last coil of the ileum; near its base it was somewhat constricted, and at this point was extremely hard and firm to the touch. As the appendix was delivered through the abdominal wound some fæculent pus escaped through a small perforation. The appendix was removed and the abdomen closed. The patient made an uneventful recovery.

PATHOLOGICAL REPORT.—The appendix is split longitudinally near its proximal end; the lumen is occupied by a typical yellow carcinomatous growth; distal to this is a concretion surrounded by fluid fæculent material. Along its mesenteric border there are several well-marked diverticula which include all the coats of the appendix (*see Fig.* 247). The perforation seen at operation was through the apex of one of these diverticula. Sections of the growth show the structure of a spheroidal-celled carcinoma.

Case 3.—C. M., female, age 17, admitted Aug. 8, 1919.

HISTORY.—For the past year patient has complained almost constantly of her stomach being out of order. Frequently, after meals, she would have epigastric pain coming on at irregular intervals and usually followed by a colicky pain in the right iliac region, and vomiting. After vomiting, both the epigastric and right iliac pains were relieved. She has had several very severe attacks of pain in the right lower abdomen which have doubled her up; she has on three occasions been confined to bed, and was told by her doctor that she had appendicitis. The last severe attack was two weeks ago, but during the long journey to hospital (Shetland to Edinburgh) patient has again had some pain and sickness.

ON EXAMINATION.—There were found some restriction of abdominal movement—especially on the right side; definite hyperalgesia and tenderness in the right iliac region; no rigidity.

OPERATION.—A gridiron incision was made. There was no peritonitis; a long engorged appendix, swollen at the tip and with a definite yellowish swelling half an inch from its cæcal end (*Fig.* 248), was removed and the abdomen closed. Uneventful recovery.

Even before the appendix was removed in this case one was able to recognize the carcinoma at the base of the organ and to correlate its presence with the symptoms of appendicular obstruction of which the patient had complained.

PATHOLOGICAL REPORT.—The appendix, split longitudinally, shows two separate yellow growths, one close to the cæcal end apparently blocking the lumen almost completely, the other at the tip (*Fig.* 249). There appears to be no connection between the two growths, which, on section, show the typical spheroidal-celled carcinoma structure. There is no evidence of any spread of the growths beyond the confines of the wall of the appendix.

These three cases are of interest because, in all, the carcinoma situated near the proximal end of the appendix gave rise to symptoms of acute appendicular obstruction which in two of the cases called for immediate surgical intervention, and in the third case led to repeated attacks until the appendix was removed.

In two of the cases the obstruction, before finally occluding the lumen completely, had caused a chronic increase in tension in the appendix leading to the formation of diverticula, through one of which perforation eventually occurred. In one case (*Case* 3) there were two separate and apparently entirely independent though similar growths in the appendix, the one at the tip, the other at the base.

These three cases were typical of appendix carcinoma in : (1) The early age incidence (15, 22, and 17 years respectively) ; (2) The spheroidal-cell type of growth ; (3) The absence of metastatic glandular involvement.

FIG. 248.—Appendix in *Case* 3. Note yellow growth shining through peritoneal coat near proximal end, and faint yellow nodule at tip.

FIG. 249.—Appendix in *Case* 3 slit open. Round yellow nodule plugging lumen near base, and small yellow growth at tip.

Graham[1] found that, in 172 cases of primary appendix carcinoma, the growth was of the spheroidal-celled type in 127 (73·8 per cent).

Reiman[2] reported 17 cases of carcinoma in 13,157 appendices examined from the clinics of Kelly and Deaver in Philadelphia, i.e., 0·13 per cent. In 75 per cent of the cases the patients were females, and in practically all the cases the tumour was situated at the tip or the distal third of the appendix.

MacCarty and McGrath,[3] in their extensive observations from the Mayo clinic, found that the average age of cases of appendix carcinoma was thirty years, that 73 per cent of the cases were females, and that in 90 per cent the disease was situated near the tip of the appendix. They found carcinoma in one out of every 225 appendices examined, and in one out of every 53 partially or completely obliterated appendices.

The disease is thus shown to be not infrequent and must be often overlooked ; moreover, it is evidently predisposed to by the chronic inflammatory changes which tend to

obliteration of the lumen of the appendix. The disease would appear to be of a peculiarly benign or carcinoid type, and to differ from all other intestinal growths with the possible exception of the carcinoma sometimes met with in the lower ileum.

Aschoff[4] doubts whether one has the right to call the tumour a carcinoma. He points out that it is made up of small solid nests of cells, the mucous membrane over which is usually intact. The microscopic appearance very closely resembles that of the epithelial formations seen in cutaneous nævi, and Aschoff suggests the name 'mucous-membrane nævi' for such growths. Luce[5] supports Aschoff's view, and suggests that these nævi may predispose to inflammatory changes in the appendix, and not be secondary to such changes as has usually been supposed. The descriptive name of 'carcinoma alveolare solidum simplex' employed by some German writers, although somewhat cumbrous, would appear to express as accurately as possible our present knowledge of this interesting growth. The question as to whether a really malignant type of carcinoma occurs in the appendix is still a matter of some doubt. Luce reports two cases of primary malignant carcinoma of the appendix, and from a study of the literature considers that 12 cases of genuine malignant disease have been recorded. In one of his own cases it is very doubtful if the disease was not primary in the cæcum. Reiman found three examples of columnar-celled carcinoma in his 17 cases, but in none was there any evidence of real malignancy.

As McKenty[6] points out, there is so far no authentic case of metastatic growth following a carcinoma of the appendix in which the spread of the disease from the cæcum to the appendix could be definitely excluded.

At present, therefore, we must regard primary growths of the appendix as being of a relatively benign character, and liable to threaten life more from the acute obstructive and inflammatory complications to which they may lead than from any intrinsically malignant properties.

The presence of two independent growths in the same appendix, as occurred in *Case* 3 of my series, is apparently unique; at least I have failed to discover any previously recorded case. If Aschoff's view that the tumour is really a nævus is the correct one, multiplicity is not unnatural. On the other hand, if the growth has locally malignant characters it is possible that the small growth found at the tip of the appendix in this case was the primary one, and that the larger tumour at the base of the appendix was a secondary graft from the lumen of the organ.

The association of diverticula in the distal portion of the appendix with an obstructing tumour in its proximal part is self-evident in explanation. I have found no special reference to it in recorded cases; but in one of the appendices figured in Graham's paper several diverticula are seen distal to the tumour. The practical importance of the presence of diverticula consists in the fact that when complete obstruction of the lumen eventually supervenes, perforation is liable to occur through one of the relatively thin-walled diverticula. To begin with, these diverticula have distinct and well-developed muscular coats; but as the diverticula enlarge, these coats become thinned and eventually deficient over their apices, and at such points rupture may occur as in *Case* 2 of my series.

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[2] Reiman, *Amer. Jour. Med. Sci.*, 1918, clvi, 190.
[3] MacCarty and McGrath, *Mayo Clinic Reports*, 1915, 450.
[4] Aschoff, *Pathologie*, ii, 798.
[5] Luce, *Beitr. z. klin. Chir.*, 1912, lvi, 419.
[6] McKenty, *Ann. of Surg.*, 1912, lvi, 419.

THE TREATMENT OF CONGENITAL HYPERTROPHIC STENOSIS OF THE PYLORUS BY RAMMSTEDT'S OPERATION.

By ROBERT A. RAMSAY, London.

Among the recent advances in knowledge of the subject of congenital hypertrophic stenosis of the pylorus the operation of Rammstedt holds an important place, representing the latest contribution of surgery to the treatment of the condition. It is proposed in this paper to consider the operation from all aspects, giving first a short account of the pathology and general principles of treatment of the condition; and, after discussing briefly other means of dealing with the obstruction, and the indications for surgical interference, to describe Rammstedt's operation in detail, giving an account of the operative technique and of the possible causes, prevention, and treatment of post-operative complications.

PATHOLOGY.

The treatment of the obstruction may be regarded as empirical, for the conflicting theories of its causation indicate that the pathogenesis has not yet been definitely explained.

It has been held that the hypertrophy is the result of spasm occurring after birth, since symptoms do not usually appear before the age of two or three weeks. It has been stated in support of this view that the degree of hypertrophy is in proportion to the age of the patient; but this statement has not been confirmed by all observers. It is hardly credible that the enormous increase in the pyloric muscle can occur in so short a time, while it is certain that pyloric spasm without hypertrophy can produce very similar symptoms.[1] Clinton Dent found an hypertrophied pylorus in a seven-months fœtus, and in the museum of the Royal College of Surgeons of England there is a typical specimen (Teratological Series No. 545.05) from a child who suffered from persistent vomiting from birth and died at the age of one week. It would seem, therefore, that hypertrophy can be, and probably is, present at birth, although obstruction sufficient to produce symptoms may only occur at a later date.

The question as to whether this congenital hypertrophy is a simple error of development or the result of intra-uterine spasm is more difficult to answer. In support of the latter explanation, Tyrrell Gray and Pirie[2] suggest a suprarenal hypertrophy or hypersecretion and consequent abnormal sympathetic action in early fœtal life, as the primary cause; John Thomson[3] argues in favour of intra-uterine derangement of the local nervous mechanism of the pylorus, and points out that the fœtus swallows liquor amnii, thus accounting for intra-uterine action of the sphincter; while Haas[4] describes the condition as a manifestation of vagotonia. The theory of intra-uterine spasm is supported by the limitation of the hypertrophy to the circular muscle of the sphincter. On the other hand, however, there are those who maintain that a simple aberration of development is the true explanation, and are not satisfied by any theory of spasm. Whatever the cause of the initial hypertrophy, it is clear that the lumen of the pyloric canal is not completely closed at birth in the majority of cases, and the reason of its ultimate partial or complete obstruction and of the consequent characteristic symptoms is the subject of further discussion.

Thomson[3] suggests that the continued growth of the muscle, limited on the outside by the peritoneal coat, takes place at the inside and encroaches on the lumen. Tyrrell Gray and Pirie[2] do not apply their theory of adrenal stimulation of the sympathetic to this stage of the condition, since the suprarenals are not found enlarged after birth; they

suggest some other source of irritation of the sympathetic, especially a tight or adherent prepuce, and also a derangement of the chemical control of the pyloric mechanism due to pancreatic insufficiency. In this connection I may state that while I have confirmed from post-mortem examination that the suprarenals are apparently normal in these infants, both to the naked eye and under the microscope, I have found the pancreas also to be normal in size, appearance, and histology; and in the male patients that I have seen, the prepuce has either been loose and not adherent or already removed by circumcision. Haas[4] carries his theory of vagotonia a step further, and considers that continued overaction of the vagus explains the obstruction.

A possible explanation which may be put forward is that the narrowing of the pyloric canal by congenital hypertrophy of the muscle produces slow emptying of the stomach, and stagnation of the contents; this might easily be the stimulus required to set up gradually increasing contraction of the already abnormal sphincter, especially since such spasm can occur in a pylorus with normal muscle; further, œdema could spread from the mucous membrane of the stomach to that of the pylorus, which is already thrown into folds, compressed by the muscle, and irritated by the forcing of food through the narrowed canal. In cases operated upon or seen post mortem the pyloric mucous membrane is seen to be thick and œdematous, while the fluid returned on washing out the stomach shows the presence of stale food and often excessive secretion of mucus.

GENERAL PRINCIPLES OF TREATMENT.

It should be remembered that the main condition to be dealt with is starvation, and the problem to be solved is how to give the infant sufficient nourishment; the methods which may be employed are either operative or non-operative. It is obvious that the ideal treatment is non-operative when this is possible, since, on account of their frequently wasted condition, the patients are not good subjects for operation; there are also several possible post-operative complications which are responsible for a considerable number of failures. But unfortunately non-operative treatment is by no means always successful, and in these cases surgery must be invoked to hasten the starting of such feeding as is necessary for life and growth.

Medical Treatment.—Since it is nearly impossible to tell in any given case whether operation will be necessary or not, medical treatment should be tried in the first instance; for this reason a brief review of the various non-operative measures will be given. The object of medical treatment is so to diminish the contraction and œdema of the pylorus as to allow the canal to revert to the partially patent state present at birth; in this way food, in a reduced quantity at least, can pass, and may be sufficient to maintain life and permit growth in a varying degree. If this ideal is attained and maintained, it is thought that absolute growth of the pylorus will cause the lumen, after prolonged and careful treatment, to become large enough for stagnation and spasm to cease and a cure to result.

Until recent years medical treatment consisted only in feeding in small amounts at short intervals, combined with regular and frequent washing out of the stomach. By these means it is hoped to prevent over-filling of the stomach and consequent stagnation, and to reduce, when present, the inflamed and swollen condition of the mucous membrane. Many drugs have been tried, such as belladonna, opium, and cocaine, but with very unsatisfactory results. Recently two new medical methods have been described in the United States. One consists in giving thick foods, and successful cases have been described.[5] I have not seen this treatment applied. The second method is that of Haas,[4] who gives large doses of atropine in the food with a view to inhibiting the action of the vagus; he increases the dose to as much as $\frac{1}{16}$ gr. in a day when necessary, and describes successful cases. I have seen a case in which this line of treatment was followed by cure, but in a case upon which I afterwards operated the patient showed signs of poisoning before a dose sufficient to affect the symptoms was reached (*Case* 9).

These medical methods of treatment are mentioned here since, in the present state

of knowledge of the subject, it is advisable in most cases that an attempt be made to avoid operation. It is not always easy to be sure that the case is not one of simple pyloric spasm, nor, in a case of true hypertrophy in which the pyloric tumour is distinctly felt, to determine the relative importance of the structural and functional factors producing the obstruction as mentioned above. In cases of pure spasm, or in those in which the actual hypertrophy is slight but associated with much gastritis, medical means will produce improvement which in favourable circumstances may progress steadily and result in cure. It is as well to point out the fact, noted by many, that a change in the method of feeding will often produce an improvement; but in severe cases this is only temporary and is soon followed by a recurrence of symptoms. The important point is that medical treatment as at present known should not be prolonged in the absence of continued, even though slow, improvement, as shown by control of vomiting and especially by gain in weight. The loss of weight occurring when unsuccessful measures are persisted in, is a serious factor in determining a fatal result after an operation that may finally be found unavoidable. The time to be spent in medical treatment must be decided for every individual case, since it depends on the age and weight of the child, its appearance, and general condition and progress; a young child that has not lost much weight when first seen, although not necessarily curable without operation, is obviously less in need of rapid relief of the obstruction than an older child severely wasted and exhausted by vomiting, to whom satisfactory feeding is an urgent necessity. Attempts have been made to fix an arbitrary time to be spent in treatment on medical lines, but no such period can be given. I consider indications for surgical treatment to be present in the case of a child so wasted and exhausted that any more loss of weight is likely to cause a fatal result should an operation have to be done later; and also in the case of a child in whom non-operative methods do not at once relieve the vomiting and produce a continued gain in weight compatible with life and growth.

Surgical Treatment.—In discussing the surgical treatment, it must be remembered that, except in the rare cases operated upon in a very early stage, the object in view is to feed the wasted infant so that it may recover from its marasmus. The object of an operation is merely to provide an outlet from the stomach so that this feeding can be carried out. The difficulties facing the surgeon lie in the extreme youth and unsatisfactory state of the patient, and the consequent susceptibility to shock. In the choice of operation, therefore, two factors must be borne in mind: in the first place, an efficient communication must be established between the stomach and the intestine; and secondly, in order to avoid severe and even fatal shock, the operation should be one that can be done quickly and should entail the least possible exposure and handling of the abdominal contents.

A brief review of the operations which have been adopted shows the superiority of Rammstedt's method. Resection of the pylorus with either gastro-enterostomy or direct union of the divided stomach and duodenum is much too formidable. Pyloroplasty, which consists in dividing all the coats of the pylorus in the direction of the axis of the canal and suturing them at right angles to this, is, as I have found in two cases, very difficult on account of the rigidity of the hypertrophied muscle, and takes a relatively long time to perform; while, because of the distortion of parts, the canal is not immediately patent. Other plastic operations present the same difficulties. Gastro-enterostomy requires exposure and handling of more than one part of the alimentary canal, and the suturing takes an appreciable time.

The modification of Loreta's operation—in which metal dilators, introduced through an incision in the stomach wall, are passed through the pylorus in increasing sizes until the circular muscle is ruptured—is not a short operation, allowing the time needed for the incision and suture of the stomach and for the necessarily slow and gentle passage of the dilators. While it is undoubtedly true that the band of muscle actually causing the constriction is ruptured, the situation and extent of this rupture is uncertain.

Weber's[6] extramucous pyloroplasty, as its name implies, is a plastic operation leaving the mucous membrane untouched and involving the muscle only; this procedure

would appear to suffer from the same disadvantages as are mentioned in the case of the older form of pyloroplasty.

Russell Coombe[7] described an extramucous division of the muscle in the axis of the canal, the peritoneum being freed from the muscle and sutured over the gap, a detail of technique prolonging the operation and shown to be unnecessary by the results of Rammstedt's method.

RAMMSTEDT'S OPERATION.

History.—The operation of dividing the hypertrophied muscular coat in the axis of the pyloric canal, leaving the mucous membrane intact and using no sutures to close the gap, was first described by Rammstedt[8] in 1912. While attempting to perform the extramucous pyloroplasty of Weber, it was found that the sutures would not hold, and the patient's condition preventing prolonged attempts to complete the operation, the incision in the muscle was left open. Recovery followed, and the possibility of leaving the muscular incision unsutured being thus proved, this was done deliberately in other cases. The operation was taken up extensively, with favourable results, in the United States, and more recently in this country. It has the advantage of simple technique, rapidity, and exposure of the least possible amount of abdominal contents, since the pylorus itself and the adjacent part of the stomach are all that need be brought out of the wound.

In a paper read before the Medical Society of London in February, 1919,[9] I discussed and compared the various operations, and attempted to show the superiority of Rammstedt's operation; I have had other cases since that time, and describe here in detail the operative technique used and the observations made.

Preparation for Operation.—Before the operation the limbs are bandaged and a subcutaneous infusion of saline is given. The theatre and table are warmed, and all the usual measures are taken for the prevention of shock. Before starting the administration of the anæsthetic, the stomach is washed out with a solution of bicarbonate of soda until the fluid is returned quite clear. This is done for several reasons: first, an empty stomach, or one containing only gas, is easier to handle than one distended with food; secondly, should an opening be made accidentally in the mucous membrane the risk of infection is lessened; thirdly, on the re-establishment of the pyloric canal, stagnant food and mucus do not pass into the easily irritated intestine; and finally, should regurgitation through the œsophagus occur during the operation, the danger of respiratory obstruction is diminished. In one of my cases (*Case* 6) breathing was stopped by a plug of mucus, and, although this was satisfactorily dealt with, the delay and necessary moving of the patient might have had serious results. Since this case a large tube (No. 14 English) has been used, so as to assure the removal of all food and mucus.

Anæsthesia.—The anæsthetic is a matter of great importance. Although in the case of such weak and wasted patients the temptation to maintain a light degree of anæsthesia is certainly present, it must be resisted, since deep anæsthesia is necessary to prevent shock and also to avoid straining and protrusion of omentum or viscera, which, should it occur, will increase the shock and delay the operation, the replacement of such a protrusion being often difficult, especially in the case of thin and wasted omentum. In my cases open ether has been used; its stimulant effect is of value, while, if induction is very gradual, the respiratory complications are avoided. I have not done the operation under local anæsthesia, and should hesitate to do so, since straining and its important results, as mentioned above, could not be prevented with certainty. I have not used spinal anæsthesia, which would have to be at a very high level in view of the part of the abdomen dealt with.

I am indebted to Mr. F. D. Bennett and Dr. Howard Jones for their help and advice on the subject of the anæsthesia.

Operative Technique.—The incision of the abdominal wall is that employed by Mr. Burghard in his modification of Loreta's operation. It is from $1\frac{1}{4}$ inches to $1\frac{1}{2}$ inches in length, in the middle line, extending downwards from the tip of the ensiform cartilage.

It is small and therefore quickly closed, since only the pylorus need be brought out of the wound; it is in the middle line so as to avoid hæmorrhage, and to reduce the layers of suturing in the process of closure; and it is placed as high as possible so that the large liver of the infant, which is rotated upwards to expose the stomach, can, at the end of the operation, fall back into its natural position, fill the wound, and so help to prevent protrusion of abdominal contents. As soon as the abdominal cavity is opened it is as well to secure the cut edges of peritoneum before they retract, and thus avoid delay when the time for closure comes (*Fig.* 250). When the lower edge of the liver has been hooked upwards, the stomach appears in the wound; the diagnosis having been confirmed by feeling the pyloric tumour with a finger introduced into the abdomen, this tumour is brought out of the wound; in some cases it can be hooked up by the examining finger; in others, pushing the stomach backwards and to the left may cause it to present; or, in the case of a greatly dilated stomach, it may be necessary to exert gentle traction upon

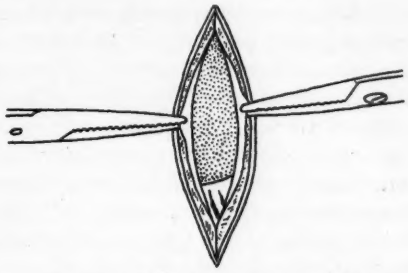

FIG. 250.—Shows abdomen opened. Liver fills greater part of wound. Stomach seen below. Forceps on peritoneal edges.

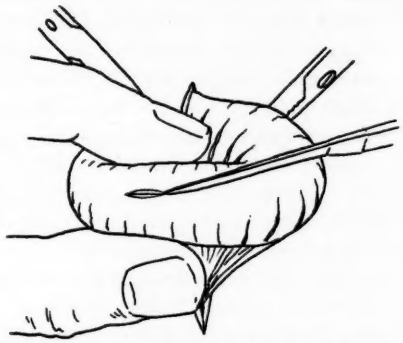

FIG. 251.—Shows pylorus held by left hand and incision begun.

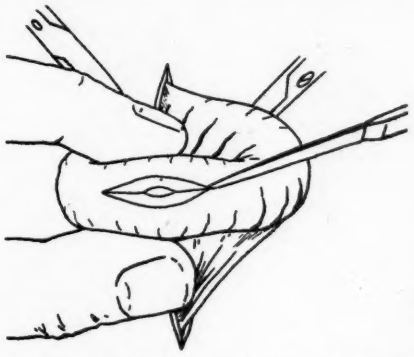

FIG. 252.—Incision deepened. Mucous membrane exposed in middle.

the exposed part of this organ and so bring the tumour within reach. The pylorus being delivered, the extent of the hypertrophy is carefully defined by palpation, and, with the tumour held firmly in the left hand, a longitudinal incision is made upon its anterior surface in the relatively bloodless area lying between the terminal branches of the vessels running along its upper and lower borders (*Fig.* 251). The incision should divide the whole of the hypertrophied muscle; it should be deepened carefully at first in the middle or thickest part, the left hand drawing apart the edges of the incision until the deepest part of the muscle is divided and retracts, exposing the thick white mucous membrane, which at once protrudes (*Fig.* 252). The incision is then prolonged towards the stomach and duodenum until all the thickened muscle is divided. Great care must be taken not to wound the mucous membrane, especially at the duodenal end of the incision, since here the hypertrophy ends abruptly and protrudes into the lumen of the intestine, producing a cul-de-sac of duodenal mucous membrane which may easily be

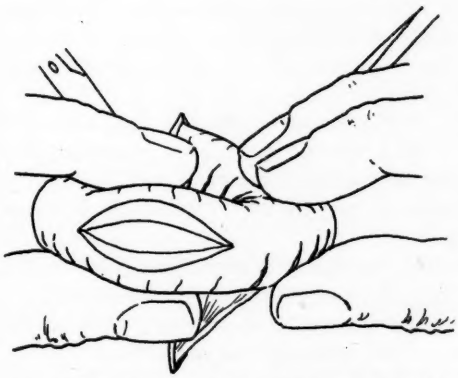

FIG. 253.—Incision completed. Margins separated by left hand. Stomach compressed by right hand.

injured. When the muscle has been completely divided, the edges of the incision retract and the redundant mucous membrane bulges freely into the gap. Hæmorrhage in the form of oozing may occur, especially at the end of the incision which encroaches on the stomach; this can usually be controlled by hot sponging, but if, as sometimes occurs, a definite bleeding point is responsible, it should be under-run and ligatured with fine catgut. The patency of the canal may be tested by gently squeezing the stomach, and this precaution also serves to demonstrate the absence of macroscopic perforation of the mucous membrane (*Fig.* 253). The pylorus is now returned to the abdomen, and the liver allowed to fall into place. The closure of the abdominal wound is begun at the lower end, since it is here that protrusion of abdominal contents is most likely to occur; a continuous suture of fine silk closes the peritoneum and aponeurosis in one layer, and a continuous blanket suture of silk or fishing-gut is used for the skin. Dressings having been applied, the patient is returned to a warm bed, saline with brandy is given per rectum, and feeding is begun as soon as possible.

Anatomical Results.—The immediate anatomical result of this operation consists in division of the constricting band of hypertrophied muscle, which at once retracts and frees the redundant and compressed tube of mucous membrane, the lumen of the latter being ample for the passage of food. As regards more remote changes, I have examined four stomachs at varying intervals after Rammstedt's operation, and the facts noted help to demonstrate the process of repair and the ultimate local result.

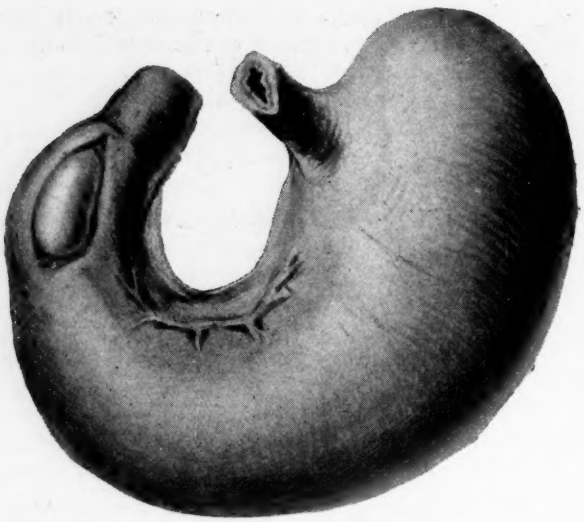

FIG. 254.—Stomach 17 days after Rammstedt's operation. (*Natural size.*)

In the case of a patient (*Case* 6) who died of hyperpyrexia twenty-six hours after operation, the pyloric canal was patent and the stomach not distended, although food had been given at regular and frequent intervals, and vomiting had been insignificant. The edges of the incision in the muscle were widely separated, and the mucous membrane was not compressed; the exposed area of mucous membrane filling the wound was intact and covered by a layer of firm blood-clot $\frac{1}{8}$ inch in thickness; there was no hæmorrhage into the abdominal cavity, and no sign of adhesions or of peritonitis.

In the case of a patient dead on the seventh day from no apparent cause except failure to assimilate, the stomach was not dilated and the pylorus was patent. The margins of the wound in the muscle were widely retracted, the mucous membrane uncompressed and covered, in the gap, by a layer of organizing lymph; there was no sign of adhesion, peritonitis, or hæmorrhage.

In the case of a patient dead of diarrhœa on the seventeenth day, the pylorus was patent and the stomach not distended. The layer of lymph covering the exposed mucous membrane was now organized, blended with the cut edges of the muscle, and partly covered by peritoneum. There were no adhesions. This specimen (*Fig.* 254) is now in the museum of St. Bartholomew's Hospital (No. 1907.A.5.).

In the case of a patient dead of diarrhœa and vomiting after four and a half weeks, the changes were similar to those found in the last specimen, but the edges of the cut muscle were less distinct and more completely blended with the surface of the gap. The lumen of the pylorus was patent. A microscopical section of this specimen cut at

right angles to the axis of the canal shows the thickened muscle ending in a rounded edge on each side of the gap ; these muscular edges are united across the gap by a thin and loose layer of fibrous tissue. The mucous membrane shows longitudinal folds, but is unconstricted, and the lumen of the canal is patent (*Fig.* 255).

I have not seen any specimen of a stomach after a longer interval than in the last case, but Ransohoff and Woolley[10] describe a case dead from other causes five and a half months after Rammstedt's operation, and state that the muscle was of normal thickness, while in the site of the incision was a shallow linear depression. The bottom of this groove was shown on a microscopical section to be connected to the submucous coat by a band of fibrous tissue ; the pyloric canal was patent and the stomach not dilated.

After-treatment.—The immediate results of the operation having been overcome, the subsequent after-treatment has for its object the feeding of the patient and recovery from marasmus. In most of my cases this has been carried on under the supervision of Dr. Cautley. As soon as the effect of the anæsthetic has passed off, a weak preparation of Horlick's malted milk is given in feeds of 1 drachm every quarter of an hour, brandy being added until the colour and pulse are satisfactory. After twelve hours the quantity and interval are doubled, and so on until after thirty-six hours the patient is taking an ounce hourly. The food is gradually increased in strength and quantity according to the needs and progress of the patient, great care being taken to avoid sudden increase or over-feeding in view of the ease with which the intestines are deranged and diarrhœa produced. During the first week the patient may gain in weight or remain stationary, but after this interval a steady and continuous gain should occur, and the appearance of the child should alter from that of severe marasmus until it becomes a healthy though, at first, small infant, the drawn and sunken features being the first sign to disappear.

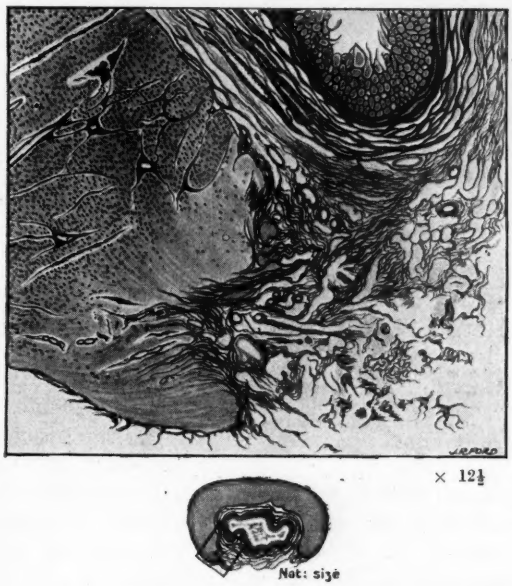

FIG. 255.—Transverse section through pylorus 4⅓ weeks after operation. The divided muscle is widely separated, the lumen large, and the gap in muscle becoming replaced by fibrous tissue.

Complications.—What has just been described is the progress and cure of a successful case ; unfortunately there are certain important complications which may occur in the post-operative period, and any of these may bring about a fatal result, even though the primary object of providing an outlet from the stomach has been achieved.

Shock.—As has already been pointed out, the operation under discussion is especially valuable in avoiding shock, on account of its short duration and of the small amount of manipulation required ; I have not had a case in which shock was severe or in which such shock as was present was not readily overcome by the usual simple methods.

Hæmorrhage.—Although in none of my cases has there been hæmorrhage sufficient to cause symptoms, this complication is sometimes a cause of death, blood being found post mortem in the peritoneal cavity in considerable quantity. The main arteries involved are the pyloric and right gastro-epiploic vessels which run along the upper and lower borders respectively of the pylorus ; these vessels send branches to the pylorus, some to the anterior and some to the posterior surface ; and in front where the incision is made there is an intermediate space between the terminations of the upper and lower groups of branches where the muscle contains no important vessel and is relatively

bloodless; as the pylorus merges into the stomach the vessels become larger and more numerous. Wishing to demonstrate this bloodless area, I injected the abdominal arteries of a fœtus through the aorta with a suspension of red lead and removed the stomach, of which skiagrams were taken for me by Mr. H. T. George (*Fig.* 256); these plates show clearly the distribution of the vessels and the bloodless area to which I have referred, and I consider it important to divide the pyloric muscle in this situation.

Peritonitis.—Peritonitis is a complication which I have not as yet met, but it has been described. It might of course be due to some fault of asepsis; but in the absence of this, infection from the interior of the pylorus is the probable cause. Whether infection can spread through the unprotected but intact mucous membrane is open to question, but the early covering of the bare area by blood-clot, as seen post mortem, renders it unlikely, and the same would apply to a microscopic injury of the mucous membrane. A macroscopic wound was demonstrated by a bubble on squeezing the stomach in one of my cases; this was closed by a fine catgut suture, and no unfavourable symptom followed, a result tending to justify the confidence just expressed in the efficacy of the protecting clot. Such a wound of the mucous membrane, if undetected and left open, could easily allow leakage, and should therefore be looked for with great care, especially at the duodenal end of the incision where the danger is greatest.

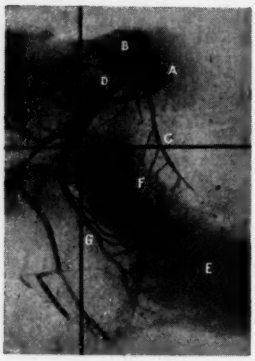

FIG. 256.—Skiagram of pylorus of infant with injected arteries. A, Cœliac axis B, Hepatic artery. C, Pyloric artery. D, Gastroduodenal artery. E, Stomach F, Pylorus. G, Right gastro-epiploic artery.

Diarrhœa.—Diarrhœa, sooner or later accompanied by vomiting, is unfortunately not infrequent, and may easily be fatal. Once established, the prognosis of the case is extremely grave, especially when the complication arises soon after the operation before the patient's general condition has had time to improve. It is therefore of great importance that the condition be prevented, and that the factors causing it be eliminated as far as possible. In my opinion there are two factors responsible for the onset of diarrhœa. The intestine of such an infant in its short life before the operation has not exercised its full normal function, since normal quantities of food have not passed out of the stomach, and it seems reasonable to suppose that the intestinal mucous membrane is more susceptible to irritation than in the case of a normal infant, and has acquired very little immunity to the cause of infective diarrhœa. Added to this predisposing susceptibility, irritation itself acts as an exciting cause, and the question of the origin of such irritation therefore arises.

In those cases in which obstruction of the pylorus is not complete, instead of the classical constipation, slight diarrhœa may be present before operation, the stools being green and liquid, although small in size and containing little food; this condition can be explained by spread of inflammation from the gastric mucous membrane to the intestine. In such a case the additional quantity of food passing through the pylorus after operation may not be dealt with normally, and diarrhœa may become severe. In one of my cases (*Case* 10) in which such incomplete obstruction existed, the operation stopped the vomiting, and the child did well till the fourth day, when the temperature rose suddenly and a large green stool was the beginning of continued diarrhœa accompanied by vomiting and leading to exhaustion and death on the seventh day. When even slight diarrhœa is present before the operation, it is very difficult to treat, since the child is not fit to be deprived of food, and the constricted pylorus maintains the unsatisfactory state of the stomach and prevents efficient administration of drugs. In such a case the stomach should be treated by thorough washing out, and the greatest possible caution exercised in feeding both before and after the operation. With a view to finding whether there is present in the stomach contents before operation any abnormal micro-organism which might be responsible for the intestinal infection, Dr. M. H. Gordon has

examined for me the washings from such a stomach and has found only the *Streptococcus salivarius*, an organism which is also found in the stomach of a normal infant.

In those cases in which there is no diarrhœa present before operation I consider the complication, when it arises, to be due to infection from without. It occurs much more frequently in hospital, where patients—usually in a more serious condition when first seen—are in wards with other infants, than in private cases where they can be completely isolated. As an example, I may quote one of my cases (*Case* 9), which fortunately was a success in the end, in which the patient suffered during convalescence from three attacks of diarrhœa, each coinciding with the admission to the ward of a case of acute diarrhœa and vomiting.

As regards prevention, breast feeding suggests itself as the obviously ideal method of post-operative treatment. Unfortunately this is usually impossible, since various artificial foods have already been tried in most cases, and the mother's milk is no longer available. One has, therefore, to be content with isolating the child as far as possible and paying the most scrupulous attention to the preparation of the food and to the care of utensils. Should diarrhœa start, in spite of precautions, general methods of treatment must be adopted; but unfortunately these are frequently unsuccessful.

Post-operative Fever.—Another complication which may cause a fatal result is hyperpyrexia. It has been noted that in cases operated upon by Rammstedt's method the temperature at once rises sharply, usually not higher than 101° to 103°, and falls again in from twenty-four to forty-eight hours. Sometimes, however, the fever is much higher, reaching 107° or 108°, and cannot be reduced even by vigorous treatment, so that death follows rapidly.

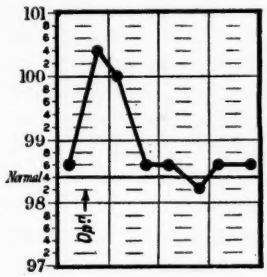

FIG. 257.

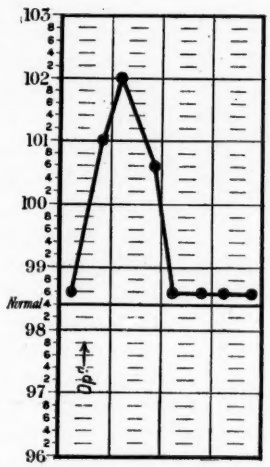

FIG. 258.

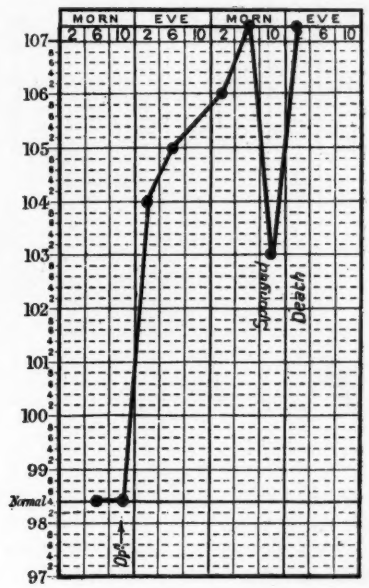

FIG. 259.

It is well known that the heat-regulating mechanism of infants is easily disturbed, and that this instability is increased in undeveloped, wasted, or exhausted patients. One would also expect that the susceptibility to irregular temperature would be in proportion to the degree of wasting and exhaustion present. A partial explanation offers itself in the lack of body fluids and consequent diminished perspiration. In all my cases, with the exception of one to be mentioned later, a post-operative rise of temperature occurred (*Figs.* 257 and 258); this was not excessive, soon fell, and had no unfavourable result except in one case (*Case* 6) in which, in spite of energetic measures, the temperature rose to 108° and the child died in convulsions twenty-six hours after operation (*Fig.* 259). This infant was much older than my other patients, being sixteen weeks of age, having been under medical treatment for seven weeks and weighing only 7 lb. at the time of operation.

I consider that in these wasted infants, so susceptible to irregular fever, the same

factor is responsible for the onset of pyrexia as for diarrhœa, when that complication occurs. The intestine is unused to food, and its resistance to extraneous substances such as food, and its absorptive powers, are not normal ; thus it seems possible that the sudden influx of food in an unaccustomed quantity may, by local irritation and abnormal absorption, initiate a rise of temperature which can easily become uncontrollable on account of the unsatisfactory general state of the patient. In my *Case* 8 there was no post-operative rise of temperature, but symptoms were not relieved, vomiting continued, and the child did not improve ; on the fifth day the abdomen was re-opened and, as will be described later, the obstruction was found to be unrelieved. A more satisfactory incision was made in the pylorus, and the abdomen closed ; symptoms ceased, and the child recovered ; but the interesting point is that after the second operation the typical rise of temperature occurred (*Fig.* 260). This case, if it does not prove the theory given above, at least suggests that the passage of food into the intestine has some influence on the post-operative temperature.

Regarding the treatment of post-operative fever, in ordinary cases nothing is necessary except to prevent too great a rise by giving sufficient air and plenty of fluid, and to see that the child is not too heavily covered. In cases in which the temperature rises to 104° or more, sponging, ice to the head, and enemata of iced water should be tried ; but hyperpyrexia, when once established, is a stubborn and usually fatal condition.

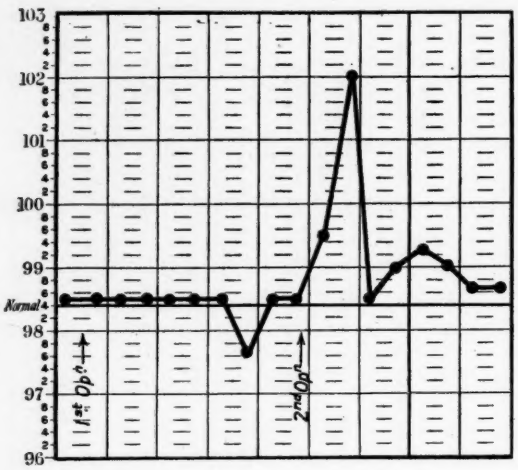

FIG. 260.

The two complications just described, diarrhœa and high fever, are the most frequent causes of death after Rammstedt's operation, and have therefore been discussed in detail. As will be seen, I consider both to be due primarily to the atrophied condition of the intestine consequent upon partial or complete starvation ; the longer such starvation has continued the greater the risk, and this is one of the main reasons for urging that no time be lost before undertaking surgical treatment in those cases in which medical methods do not show early signs of success.

Recurrence of Symptoms.—A final complication that must be mentioned is recurrence of symptoms due to insufficient division of the constricting muscular band. It is suspected if typical vomiting does not cease immediately after the operation ; a few small vomits after the anæsthetic may occur and, as in any baby, small regurgitations may be frequent ; also vomiting may take place on moving the patient, or after an increase in feeding ; but there should be no large projectile vomits of collected food. Should such occur and continue, it is probable that some part of the constriction still exists and, while washing out may be tried for a short time, a second operation should not be delayed.

Tyrrell Gray[2] describes a case in which a constriction at the gastric end of the pyloric incision was responsible for continued symptoms. Cases have occurred in which only the middle of the muscular band was divided, leaving a constriction at each end between which the mucous membrane bulged like a hernia. In my own *Case* 8, already mentioned, the second operation showed that the edges of the incision in the muscle had met and were united by organizing lymph ; fortunately, re-opening and lengthening of the original incision resulted in cure. I am unable to explain what had happened in my case of recurrence ; the muscle usually retracts widely and the mucous membrane bulges freely, and at the first operation nothing unusual was noticed ; possibly some fibres at the bottom of the incision and part of the constricting band at its ends were not divided ; the child was only three weeks old, not greatly wasted, and the undivided fibres may

TABLE OF THE TEN CASES OF RAMMSTEDT'S OPERATION UPON WHICH THE AUTHOR'S PAPER IS BASED.

Case	Sex	Weight at Birth	Age, First Symptoms	Place	Previous Treatment	Age at Operation	Weight at Operation	Character of Pylorus	Progress	Result
No. 1 E. S.	F.	lb. oz. ?	2 weeks	Hospital	Four weeks' lavage and feeding in hospital, with no improvement and loss of weight	9½ weeks	lb. oz. 6 5½	Large and white	No vomiting, but no gain in weight	Died suddenly 7th day
No. 2 A. A.	M.	8 7	2½ weeks	Hospital	Four days in hospital. Lavage and feeding, with rapid loss of weight	5 weeks	6 13½	Large and white	Recovery only interrupted by an attack of influenza 1 month after operation	Cured
No. 3 D. T.	F.	?	3½ weeks	Hospital	Two days in hospital. Lavage and feeding. No improvement	8½ weeks	5 2	Large and white	No vomiting. Fourteen days' rapid improvement and gain of 10 oz. Then diarrhœa and vomiting, which continued	Died 4½ weeks after operation
No. 4 C. R.	F.	7 0	7 weeks	Private	Four weeks' careful diet. Lost weight from 10 lb. at 7 weeks	12 weeks	6 14	Large and white	Uninterrupted recovery	Cured
No. 5 J. Y.	M.	7 8	10 days	Private	Three weeks' careful diet, with continued loss of weight	5 weeks	6 5	Small and vascular	Uninterrupted recovery	Cured
No. 6 D. D.	M.	9 0	10 days	Private	Seven weeks' careful diet and lavage, with no continued improvement	16 weeks	7 0	Small and vascular	Temperature rose to 105° in 12 hours and to 108° in 20 hours. Convulsions. No vomiting	Died after 26 hours
No. 7 C. E.	M.	9 0	2 weeks	Hospital	Two days' lavage and feeding in hospital. No improvement	5 weeks	8 6	Large and white	Diarrhœa and vomiting with fever began on 4th day and continued	Died 17th day
No. 8 J. N.	M.	7 8	2 weeks	Private	Careful diet and lavage 1 week. Continued to lose weight	3 weeks	6 4	Large and white	Vomiting did not cease. Abdomen re-opened and pyloric incision enlarged on 5th day. Uninterrupted recovery	Cured
No. 9 L. J.	M.	?	3 weeks	Hospital	Careful diet and lavage in hospital 2 weeks. Atropine tried but unsuccessful. Continued vomiting and loss of weight	6 weeks	6 7	Thin and vascular	Three attacks of diarrhœa and vomiting, but final recovery	Cured
No. 10 J. W.	F.	5 5	5 weeks	Hospital	Careful diet and lavage in hospital 3 weeks. Continued vomiting and loss of weight from 6 lb. 8 oz on admission. Had slight diarrhœa before operation	10 weeks	5 15	Large and white	No vomiting after operation. Fourth day large green stools and fever. Diarrhœa continued	Died 7th day

have been sufficient to bring the edges of the incision near enough to each other for union to have taken place. Great attention should be paid, therefore, to complete division of the hypertrophied band of muscle at its extremities and at its deepest part; further, the muscle should be separated, by blunt dissection at each side of the incision, from the underlying mucous membrane, ensuring the bulging of the latter into the gap.

The table on page 407 comprises the ten cases upon which this paper is based. Five died, but none were fatal from the shock which was a frequent termination after the older operations. Although the total number is small, the 50 per cent mortality is a reduction on the usual older figures, and it is hoped that the frequency of success will increase as the cause and means of prevention of serious complications become better known.

The details of technique and the various post-operative complications of Rammstedt's operation have now been discussed, and it is seen that although the operation itself is simple, and attains its object of re-establishing the pyloric canal without at once killing the patient, these complications are of a serious nature, and, until they are thoroughly understood and methods for their avoidance and cure discovered, the final mortality of the procedure will not be as low as could be desired, although it already shows a great improvement on that of the earlier methods of surgical treatment in most hands.

As has already been said, medical treatment would be the ideal, but the very diversity of opinions and theories regarding the cause and treatment of the condition shows that these are not yet clear. In each case different factors predominate, and it is only by collecting all the facts and opinions that in time the true explanation will emerge; it is partly in the hope of adding something, however little, to the knowledge of the subject that the observations and views contained in this paper are put forward.

But while waiting for the ideal treatment to be discovered, patients suffering from congenital pyloric stenosis must be treated by the methods we already possess, and a certain varying proportion will require operation. The chief object therefore of this paper is once more to express the opinion that Rammstedt's is the operation of choice, and that its performance should not be delayed, for the reasons given above, in cases in which medical treatment is unsuccessful; and also to give the writer's personal experience of the operation from all aspects in the hope that it may be of some value to others, and possibly add to the general knowledge of a procedure which has its undoubted value as part of a large and interesting subject.

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[7] Russell Coombe, *Ann. of Surg.*, 1911, liv, 167.
[8] Rammstedt, *Med. Klin.* 1912, No. 42, 1702, and *Zeits. f. Chir.* 1913, xl, No. 1, 3.
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THE DEVELOPMENT OF CYSTS IN CONNECTION WITH THE EXTERNAL SEMILUNAR CARTILAGE OF THE KNEE-JOINT.

By ROBERT OLLERENSHAW, Manchester.

In my work in the orthopædic department of Salford Royal Hospital I have now met with three instances in which cystic changes had occurred in the external semilunar cartilage. The condition has been recorded previously by several German observers. In 1904 Ebner[1] reported one case in great detail; in 1906 Schmidt[2] recorded a case, and in 1915 Riedel[3] described 6 cases upon which he had operated. Eden[4] also reported 2 cases in 1911. In 1909 Mr. Furnivall, who was then a member of the honorary staff of the London Hospital, told me of a recent example and referred to another case with which he had dealt. He presented a specimen to the museum of the Royal College of Surgeons. I have examined this specimen, which shows precisely the same condition as is seen in my own cases.

The museum catalogue describes it as follows: "The chief portion of a right semilunar cartilage removed by operation from the knee-joint. Projecting from the outer attached border there is a somewhat hemispherical swelling which extends for about half an inch along the cartilage and attains a maximum eminence of half an inch. As seen in the divided surfaces, the swelling consists of a series of well-defined spaces which, in the recent state, were filled with a thick, transparent, mucoid material. The smallest spaces appear as clefts between the bundles of white fibrous tissue at the periphery of the fibrocartilage, and seem to have arisen from a mucoid softening of the tissues and not in any way to be connected with the attached portions of synovial membrane. From a man, age 30, who slipped and fell, injuring the right knee four months before coming under observation. About a month later he noticed a swelling on the outer side of the joint; this slowly increased and troubled him in walking; it was especially uncomfortable at night and in the morning, without ever causing actual pain. On examination, there was found a swelling as large as a small filbert over the region of the external semilunar cartilage, just in front of the external lateral ligament: it was fixed to, and moved with, the tibia, and was unaffected by contraction of the biceps. The movements of the joint were smooth, and the other structures of the knee were normal. There was no affection of any other joint, and there was no history of gout or rheumatism. The parts shown were removed by longitudinal incision over the swelling.

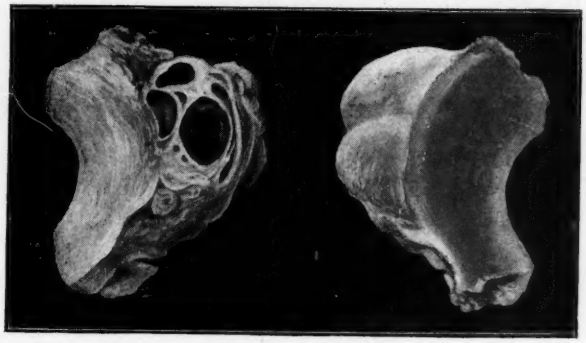

Fig. 261.—Specimen in R.C.S. Museum.

"The swelling was wholly inside the capsule of the joint. The wound healed by first intention, and the function of the joint was afterwards perfect."

Fig. 261 shows a drawing which Mr. Sewell has made of this specimen. The clinical history of all the cases seems to be similar; all have a history of an injury, usually not severe, with gradually increasing pain and lameness, and with the development of

a swelling over the external cartilage about the junction of its anterior and middle thirds. The swelling is rounded, and varies in size from a half to one inch in diameter. It is tense but distinctly fluctuant. *Fig.* 262 is a drawing from a photograph of one of the cases, and shows the appearance and position of the tumour very well.

My first patient, a man, age 40, had been operated upon eighteen months previously because of pain in the knee and the localized swelling. The cyst alone was removed. Six months later the swelling and pain recurred. A scar of an oblique incision over the anterior part of the cartilage was present. At operation I found that the cyst wall was adherent to the skin scar of the first operation, and my incision opened up the cyst, from which a clear glycerin-like fluid escaped. I excised the whole cartilage with the cyst.

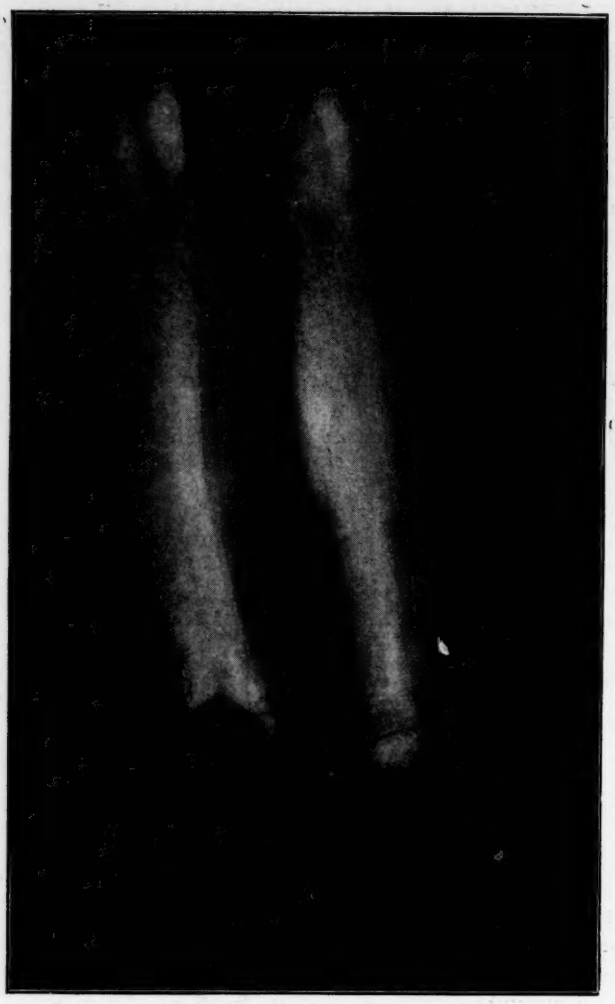

FIG. 262.

The second and third cases, men of 20 and 26 years, showed the same clinical picture, except that they had not been operated upon before, and in both of them the cartilage was removed with the cysts intact. The after-progress of all three cases was quite uneventful, and all recovered full function with freedom from any discomfort. *Figs.* 263, 264, 265, and 266 illustrate the specimens removed from these men.

As to the pathology of the condition, I supposed at first that the cysts were probably the end-result of hæmorrhage or were produced by myxomatous degeneration of cartilage consequent on the trauma. Macroscopically the cysts are multilocular and appear to develop in the substance of the fibrocartilage near its outer border. They gradually enlarge and, taking the line of least resistance, project on the outer side. The lining is smooth and shining, and the contents are a clear mucoid material. Sections of the cartilage and cysts show, microscopically, a distinct lining to the cysts. The lining is a flattened endothelium similar to the synovial membrane endothelium. The presence of this endothelial lining is entirely opposed to the idea of a degeneration cyst or a cyst following on a hæmorrhage. In the drawing of the specimen shown in *Fig.* 263, the large cystic spaces are well shown. In the section of the cartilage itself, immediately below the cyst, a small space in the actual cartilage is to be seen. This appears to be an early cyst in the process of distention. *Fig.* 266 shows a large cyst occupying nearly the whole of the transverse section of the cartilage. This was part of the specimen taken from my first case, which had been operated upon eighteen months previously, and in which a recurrence had taken place. *Fig.* 267 illustrates

FIG. 263.—Specimen removed from second case. Note the small cyst developing in the cut surface of the fibrocartilage.

FIG. 264.—Specimen from third case.

FIG. 265.—Specimen from third case.

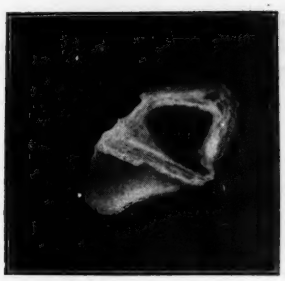

FIG. 266.—From first case. Showing a large cystic space completely surrounded by fibrocartilage.

the microscopical appearance of the cyst wall; the endothelial lining, with its nuclei, is well shown.

Ebner states that the cysts in his case showed no evidence of endothelial lining. Endarteritis of vessels in the surrounding connective tissue was present, though whether as a result of trauma or of pressure from the cysts he could not decide. In his case a yellow colour in the cartilage suggested degenerative changes. Schmidt found no endothelial lining in his specimen and no vascular changes. His case is particularly interesting, because he operated upon it three times before finally removing the cartilage. At the first and second operations he removed the cysts alone, and recurrences followed in four and six months.

Riedel had two recurrences in cases in which he simply removed the cysts. He remarks that in the case of wrist ganglia spontaneous disappearance is not infrequent, but that such an occurrence has never been recorded in the case of cysts connected with the knee cartilage.

FIG. 267.—Microphotograph of the cyst wall, showing endothelium. (*From the Pathological Department, Salford Royal Hospital. Dr. C. E. Jenkins.*)

In spite of this, Schmidt classifies these cysts as ganglia, defining a ganglion as a cyst formed by the softening of para-articular, tendinous, or periosteal tissues caused by colloid degeneration consequent on deficiency in nutrition following trauma. Riedel also refers to a case of Haehnel in which two operations for removal of cysts were each followed by recurrence, and a third for removal of the cyst-bearing cartilage effected a cure.

My own view is that the cysts are developmental in origin, due to small endothelial inclusions in the cartilage during its development, and that trauma causes an irritation and a distention of the spaces. In the knee-joint the semilunar cartilages are developed in folds of synovial membrane which are derived from the interchondral disc, and it is not difficult to imagine that in the disappearance of the interchondral disc and its replacement by joint-cavity, capsule, and synovial membrane, small inclusions may occur in the folds of membrane in which the semilunar cartilages are ultimately developed. The lesion has occurred in the external cartilage in all of my three cases. It was also in the external cartilage in all the other reported cases. The explanation of this fact I am unable to determine. No instance of its occurrence in the internal cartilage has been reported. If trauma is a causative factor, it seems extraordinary that the inner cartilage, which is so frequently injured, should not be the seat of the lesion on most occasions. The pathological condition is obscure and interesting, and from the point of view of treatment the most important fact is that local removal of the cyst is frequently followed by recurrence, and that only a complete removal of the cyst-bearing cartilage provides a permanent cure.

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ON A FURTHER SERIES OF 500 GOITRE OPERATIONS, WITH SPECIAL REFERENCE TO AFTER-RESULTS.

By JAMES BERRY, London.

A paper delivered before the Surgical Section of the Royal Society of Medicine, Jan. 5, 1921.

It is, in my opinion, the duty of every surgeon who enjoys unusual opportunities of performing large numbers of any particular surgical operation, to publish from time to time details of his cases with, so far as he can, an accurate record of his results, both immediate and remote. Any complications that have occurred, any improvement or alteration in his practice, any mistake that has been made—in short, any lesson that he has learnt from the study of his cases—should be made available for the benefit of others who have to deal with similar cases.

In the following pages I propose to give, as far as space will allow me, an account of all the cases in which I have removed any portion of the thyroid gland during the period from Jan. 1, 1913, to Dec. 31, 1919. These operations, five hundred in number (Nos. 752–1251),* form a direct continuation of previous series which have been already published elsewhere.†

The 87 operations which I have performed from the beginning of 1920 up to the present time, being too recent for my present purpose, have not been included in this series, although I make use of one or two of these to illustrate special points.‡ On the other hand, 24 cases of operation for exophthalmic goitre performed during 1913 and already published in detail in the British Journal of Surgery§ are necessarily included in the present series.

I. SEX AND AGE INCIDENCE.

Table I.—Sex and Age Incidence of the Series of 500 Cases (No. 752–1251 inclusive‖).

Males		Females	
15–19 years inclusive	6	14–19 years inclusive	26
20–29 ,, ,, ...	12	20–29 ,, ,, ...	95
30–39 ,, ,, ...	8	30–39 ,, ,, ...	139
40–49 ,, ,, ...	10	40–49 ,, ,, ...	119
50–59 ,, ,, ...	16	50–59 ,, ,, ...	45
60–69 ,, ,, ...	4	60–69 ,, ,, ...	13
70–75 ,, ,, ...	7	70 and over	0
Total males	63	Total females	437

The youngest patients were five girls aged 14, the subjects of parenchymatous goitre, rapidly growing, causing dyspnœa, and failing to respond to medical treatment. In all

* Performed upon 496 patients: one malignant, one exophthalmic, and two others having been operated upon twice.

† *Proc. Roy. Soc. Med.*, 1907, Dec.; *Trans. Med. Soc. Lond.* vol. xxxvi; *Lancet*, 1913, March; and elsewhere.

‡ The figures used to illustrate this paper are also, in some instances, taken from cases before or after the present series, as will be seen from the accompanying reference numbers. Owing to war troubles (want of preserving fluid and jars, and other reasons), a large number of the actual specimens of this series, including some of the most important, were thrown away without my knowledge.

§ *Brit. Jour. Surg.*, 1914, i, No. 4, p. 699.

‖ These numbers refer to operations for the removal of goitre, and form part of a consecutive series from the year 1888, when No. 1 was performed.

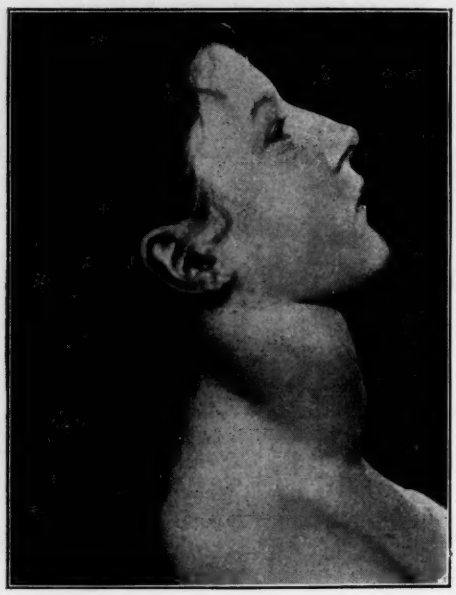

FIG. 268.—No. 1776. Parenchymatous goitre causing dyspnœa. F., age 14. Resection-extirpation of R. lobe. Weight of portion removed 7 oz.

The oldest female patient in this series was a lady, age 66, with dyspnœa and tachycardia, from whom an old, partly calcified, adenoparenchymatous goitre weighing 4 oz. was removed, with complete relief.

Among the male patients, seven were 70 years of age or over; all made good recoveries; in most of these the tumours were large and unilateral, with much displacement of the trachea and larynx. One of these patients, age 74, had first consulted me thirteen years previously on account of a cystic tumour as large as an orange, but had postponed operation until a huge tumour occupied the whole of the right side of the neck, displacing the larynx and trachea so much that he had had alarming attacks of suffocation, which drove him to operation. The thick-walled cyst, which was removed without difficulty, cases the goitre was of considerable size: in one the portion removed weighed 11¼ oz.; all made good recoveries and are quite well now.

Operations in children below the age of puberty are hardly ever necessary, and on account of the danger of interfering with subsequent growth and nutrition they should never be undertaken except for some very urgent reason. Operations for mere deformity in children are in my opinion quite unjustifiable. On the other hand, parenchymatous goitres at or about the age of puberty and later, if growing rapidly and causing really serious stridor and dyspnœa, often urgently demand operation if they do not yield to medical treatment. The trachea in such cases is so soft that it can easily be fatally occluded by a double goitre, especially if the lower part of the latter be situated low down behind the sternum, as it so often is.

The youngest among the male patients were two boys, age 15; the cases were exactly similar to the preceding.

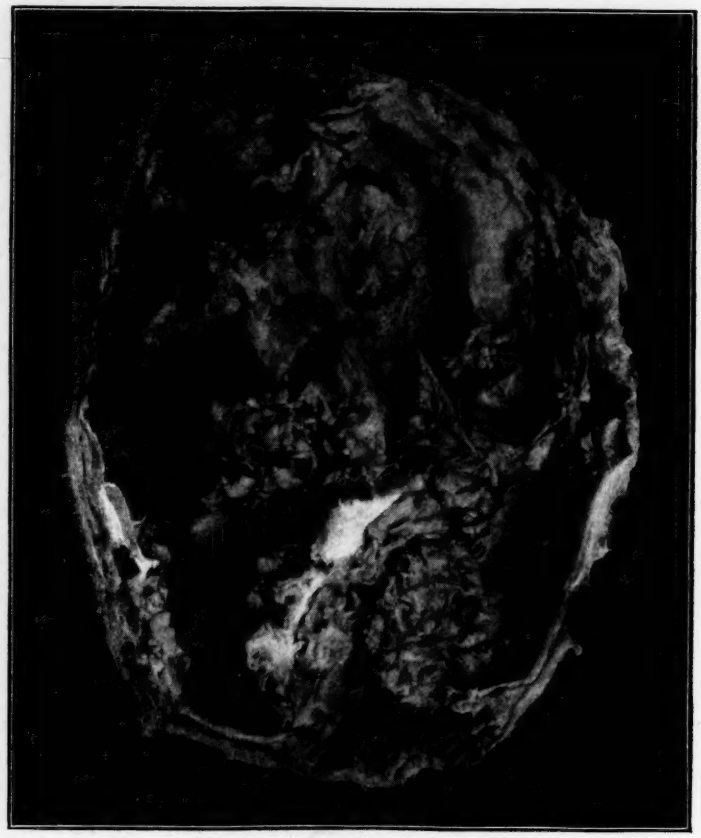

FIG. 269.—No. 103. Old cystic adenoma with thick fibrous and calcified wall. Interior was filled with broken-down blood-clot and colloid. Removed from a doctor, age 60. (*R. Free Hosp. Mus.*—xxii. 48.)

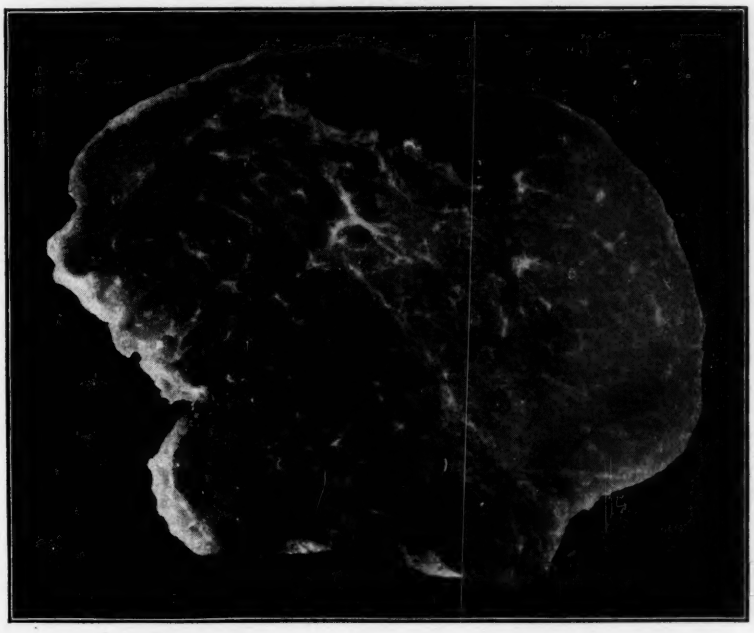

FIG. 271.—No. 1313. Portion of a parenchymatous goitre causing dyspnœa. F., age 14½. Extirpation of R. and lower half of L. lobes. Weight 6¼ oz. Shows commencing fibrosis and much reduction of colloid from prolonged previous medical treatment.

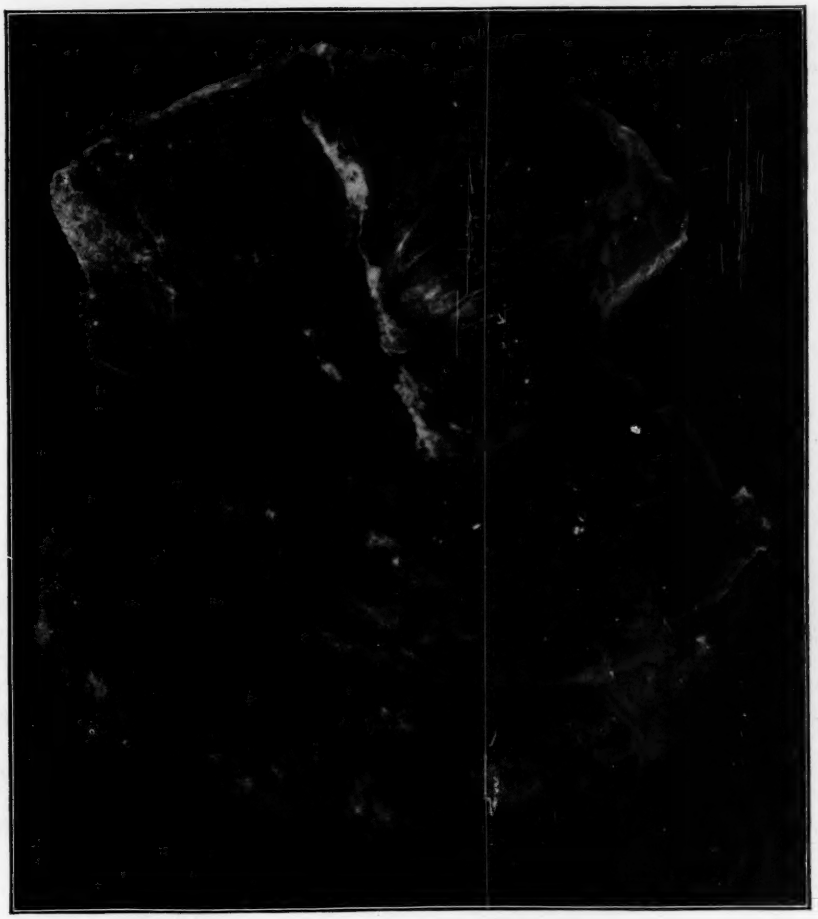

FIG. 270.—No. 1306. Parenchymatous goitre causing dyspnœa. M., age 15. R. lobe and about two-thirds of L. removed. Weight 8¼ oz.

contained a pint of brown, porridge-like material, a mixture of colloid and old blood-clot with much cholesterin.

The oldest patient of the series, a minister, age 75, was operated upon nearly five years ago for a retroclavicular goitre causing much stridor and dyspnœa. The tumour weighed over half a pound. The patient is now hale and hearty at 80. Another patient, a man of 73, with a solid, largely calcified, adenomatous mass of many years' duration, weighing 22¼ oz., is in excellent health at the age of 80. His wound healed per primam, the highest temperature after operation having been 99·8°.

The removal by resection-enucleation of these large prominent unilateral tumours in old people is, in my experience, a very satisfactory operation. The tumours are often old tough-walled cysts ; the removal involves but little interference with the thyroid gland tissue itself ; the vessels are usually very easily secured ; provided the strictest attention be paid to asepsis, to the complete arrest of all hæmorrhage—even the most trifling oozing —and the wound be drained for at least a few hours, the results are very satisfactory.

II. PROPORTION OF HOSPITAL TO PRIVATE CASES.

Table II.

Hospital cases	Male	.. .. ..	29	
	Female	.. .. ..	227	
			—	256
Private „	Male	.. .. ..	34	
	Female	.. .. ..	210	
			—	244
		Total		500

It will be seen from the above table that the number of hospital and private patients were about equal, nor was there, on the whole, much difference between the severity of the cases in the two classes. Only among the exophthalmic goitres did the hospital cases (50) considerably exceed the private (29), doubtless owing to the fact that hospital patients are less able to afford prolonged rest and medical treatment, and therefore come earlier and more readily to operation.

III. NATURE OF THE GOITRE.

Table III.

Encapsuled :—			
Solid adenoma	.. ..	88	
Cystic „	.. ..	109	
Pure cyst	.. ..	1	
		—	198
Non-encapsuled :—			
Parenchymatous	.. ..	70	
Adenoparenchymatous	.. .. ..	137	
Inflammation (acute or chronic)	.. ..	3	
True exophthalmic	.. ..	79	
Malignant and papilliferous	.. .. ..	13	
		—	302
	Total		500

It may be admitted at once that the above classification is, pathologically, not strictly accurate ; but it is convenient clinically. The term parenchymatous used here for the uniform enlargement of the gland with distention of all the vesicles—the commonest goitre of young people—is a well-established term difficult to replace by any more exact, and pathologically more correct, expression.

The term adenoparenchymatous is used loosely for the more lobulated, and often nodular, goitres of middle-aged and elderly people in which, embedded in the midst of parenchymatous goitre-tissue, there are encapsuled masses of atypical thyroid tissue, sometimes solid, but often breaking down into cysts. Sometimes these masses are true adenomata, more often they are not.

FIG. 272, *a* and *b*.—No. 1238. (*a*) Parenchymatous goitre, 30 years' duration, with some adenomata, (*b*) Side view. Treated by bilateral resection-extirpation. Nine-tenths of R. lobe three-quarters of L. Weight 22 oz.

FIG. 273.—Section of part of the above. (*Photos by Miss G. Matthews.*)

FIG. 274, *a* and *b*.—No. 993. (*a*) Adenoparenchymatous goitre causing dyspnœa and considerable distention of veins at root of neck. F., age 27. (*b*) Side view. Extirpation of R. lobe. Weight 12¼ oz. Six years later remaining lobe had enlarged considerably.

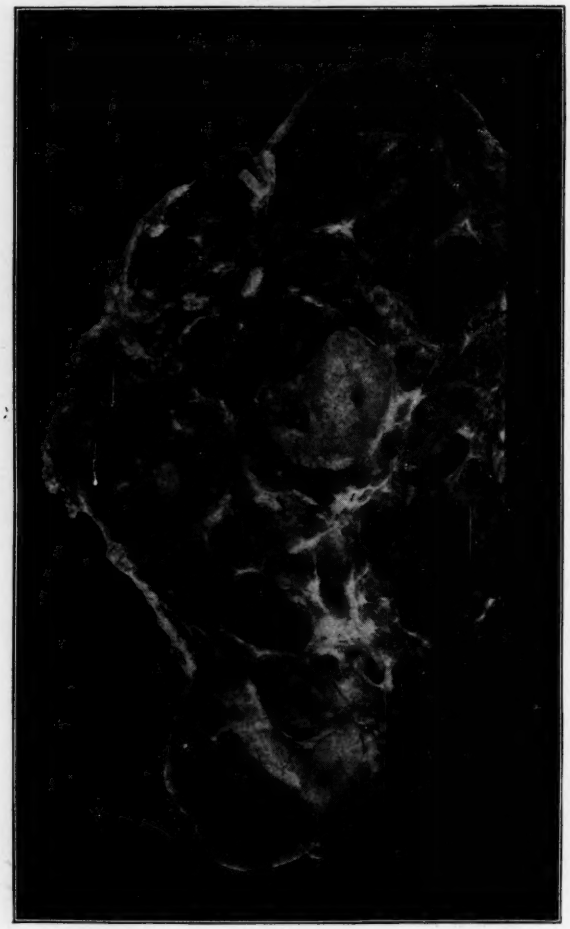

FIG. 275.—Section through goitre removed from preceding. Lobulation and fibrosis more advanced than in *Fig.* 271, No. 1313. Solid adenomatous masses in various parts.

Pure cyst is a term used for a single cyst with smooth lining like a hydrocele, a somewhat rare condition compared with the much more common form of cyst which is formed by the breaking down of a previously solid encapsuled adenoma, the remains of which can generally be seen adhering to the interior of the cyst wall. The distinction is clinically of some importance, since it is the soft vascular tissue in the interior of the common thyroid cystic adenoma that is so likely to give rise to intracystic hæmorrhage, occurring spontaneously or after slight injury.

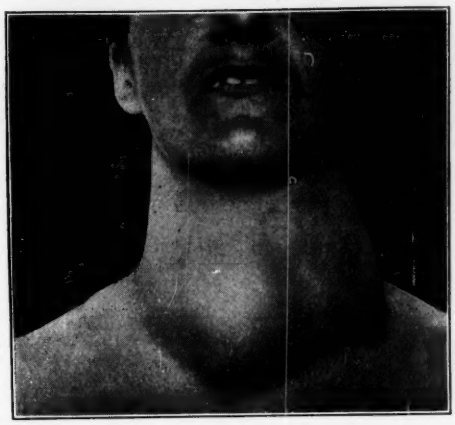

FIG. 276.—No. 948. Adenoparenchymatous goitre causing dyspnœa. F., age 37. Bilateral resection-extirpation. Weight 18 oz.

FIG. 277, *a* and *b*.—No. 989. (*a*) Old parenchymatous goitre causing dyspnœa. M., age 50. (*b*) Side view. Extirpation of most of L. and lower half of R. lobe. Weight 8¾ oz.

In a large number of the encapsuled tumours removed there was abundant evidence of recent or old hæmorrhage having occurred before operation. But this very rarely occurs in parenchymatous goitre.

It is usually quite easy to make a differential diagnosis between encapsuled and non-encapsuled thyroid tumours, a matter of much importance as regards the question of operation. On the other hand, to say definitely that an encapsuled tumour is wholly cystic or wholly solid, or partly one and partly the other, is usually impossible; but from the point of view of operative interference this is a matter of comparatively little importance, since both have to be treated in a similar manner.

The three cases of inflammation are of sufficient interest to be given in detail.

Case 1.—A suppurating cyst as large as a small walnut in a lady, age 37 ; only a few days prior to operation she had first noticed a smooth, hard, movable swelling in the neck, the most prominent feature being pain. On removal it proved to be an old cystic adenoma containing thin purulent fluid ; the tumour was freely removed, the wound drained for two days, and a rapid recovery ensued. Two and a half years later she wrote to say that she had been quite well ever since.

Case 2.—A married lady, age 36, who had had a rounded lump in the neck for about two years. It was about as large as a pigeon's egg, and as she gave a history of its having varied a good deal in size, it was thought to be an ordinary cystic adenoma. As it was not causing any trouble, I at first advised against any operation ; but as she came back later complaining of a

FIG. 278.—No. 262. Adenoparenchymatous goitre removed for dyspnœa. At upper pole is a well-encapsuled cystic adenoma. F., age 42. Weight 6 oz.

good deal of pain, the tumour was removed. It proved to be a solid, non-encapsuled mass involving the whole of the left thyroid lobe, which was removed. It consisted almost entirely of chronic inflammatory tissue of a pale yellowish colour, without colloid and without any evidence of actual suppuration.

The wound healed apparently per primam, and she left the home at the end of a week. Subsequently suppuration occurred and the wound had to be reopened on two occasions ; it did not finally heal until two months after the operation.

In neither of these cases was the cause of the inflammation clearly ascertained.

Case 3.—This case was that of a lady doctor, age about 46, who underwent removal of the right thyroid lobe for what was probably an early stage of so-called 'canceriform' primary chronic inflammation (Riedel's disease). The patient came complaining of a painful lump in the neck of two months' duration. It was obviously thyroid, and not much larger than a hazel-nut. It was hard and knobby, and did not move quite so freely upon the larynx as an ordinary innocent tumour of the thyroid should. There was no dyspnœa, dysphonia, or dysphagia, and the only

symptom was a certain amount of pain on both sides of the neck. It was thought to be probably a small cyst in the middle of an old and hitherto unnoticed goitre, especially as two other members of her family were known to have goitres. But in view of the serious possibility of the case being one of early malignancy, the right lobe was removed, the operation presenting no difficulty of any kind.

The pathological report (by Dr. Helen Chambers) was: "The outer surface is smooth and somewhat white and opaque. On section, the tissue is white and firm and contains numerous white, narrow, fibrous strands passing through it in all directions. No colloid can be seen. The macroscopic appearance suggests a chronic inflammatory condition of the thyroid gland. On

FIG. 279 *a* and *b*.—No. 1261. (*a*) Adenoparenchymatous goitre, 28 years' duration. (*b*) Side view. Bilateral resection-extirpation for bulk, deformity, and dyspnœa. F., age 48. Weight 19 oz. (*Photos. by Miss B. Rickard.*)

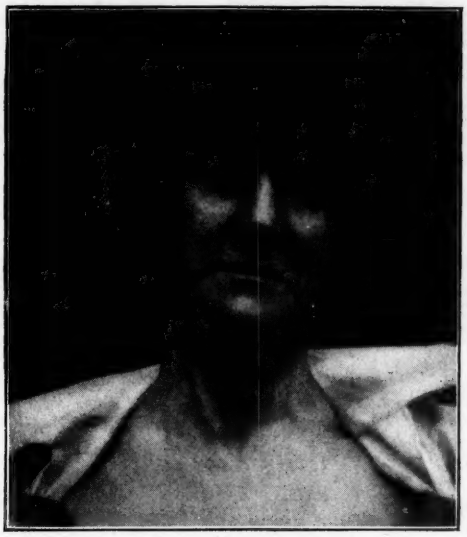

FIG. 280 *c*.—The same patient as in *Fig.* 279, one year after operation.

microscopic examination no normal tissue can be found. The section shows chronic inflammatory changes, and it is certainly not a malignant growth. . . . . The cause of the inflammatory condition is not evident".

The opposite lobe appeared to be quite healthy. The wound healed at once. Five months later the patient wrote that she had been quite well ever since the operation. Three weeks ago (6½ years after the operation) she wrote from abroad that her "health has been and is excellent", and that there is no sign of any recurrence. She adds the interesting note that a sister of hers who had had a goitre since childhood has recently died of malignant disease of the thyroid.

True Exophthalmic Goitre.—In this class (79 operations on 78 patients) have been placed only those cases in which not only the clinical symptoms, but also the naked-eye

FIG 281.—Section through right lobe of No. 1261, showing much old fibrosis,

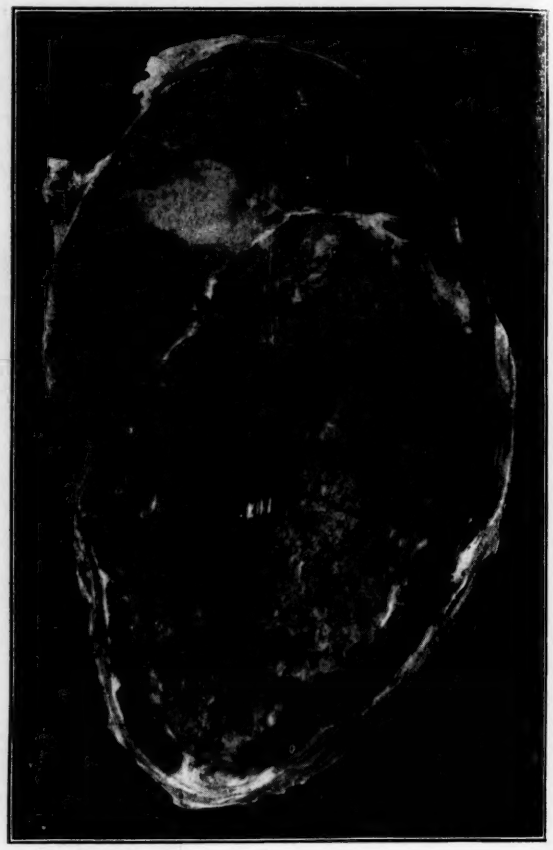

FIG. 282.—Section through left lobe of No. 1261, showing a large cavity which contained broken-down blood-clot and colloid.

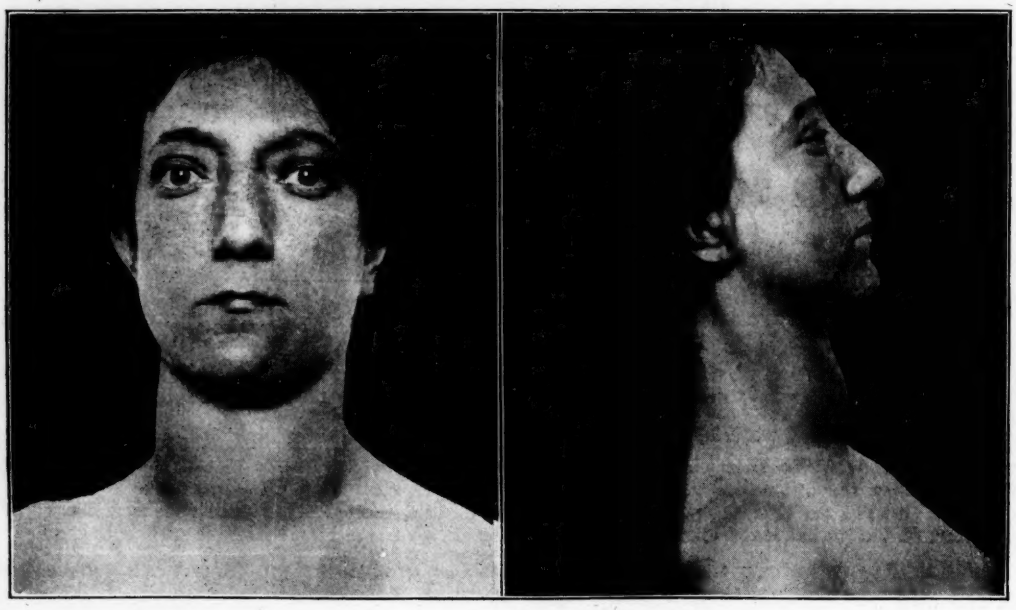

FIG. 283, *a* and *b*.—No. 867. F., age 25. (*a*) Typical exophthalmic goitre, 4 years' duration. (*b*) Side view. Treated by extirpation of right lobe.

and microscopic appearances of the disease, were quite characteristic. There was, however, one doubtful exception in which for some unexplained reason the pathological report received apparently failed to confirm the clinical diagnosis, which appeared to admit of no reasonable doubt.

FIG 284.—Nos. 1029 and 1315. Typical exophthalmic goitre removed from lady, age 29. Weight 4 oz.

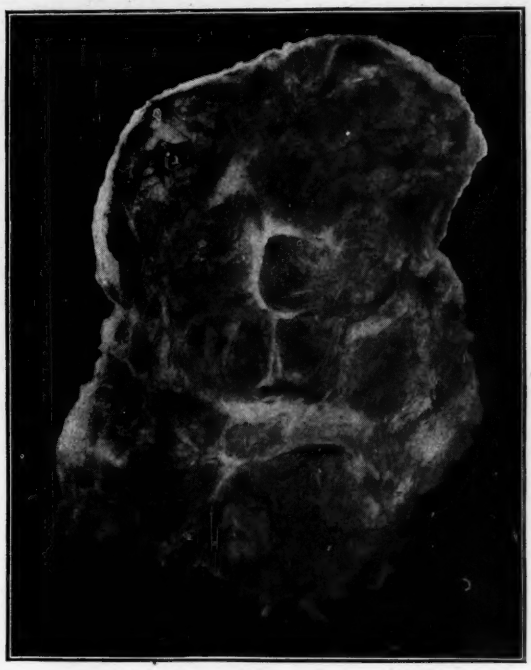

FIG. 285.—No. 1265. Part of a papilliferous carcinoma removed from a man, age 57. (*R Free Hosp. Mus.—Ea. Pb.* 402.)

Cases of 'false' exophthalmic goitre, that is, of tachycardia, tremor, etc., without exophthalmos, and mostly with unilateral tumours, have been rigidly excluded from this class. In some of these cases, the apparent symptoms of Graves' disease, especially the palpitation and tachycardia, would appear to have been caused by long-continued and excessive administration of thyroid-gland preparations. The inclusion of such cases among those of true exophthalmic would be, in my opinion, quite misleading, although it is often done.

FIG. 286.—No. 1140. Spheroidal-celled carcinoma removed from F., age 65. (*R. Free Hosp. Mus.—Ea. Rb.* 426.)

Malignant and Papilliferous.—This group of 12 patients (13 operations, one patient with papilliferous carcinoma having been operated upon twice within the period) includes tumours of very different degrees of malignancy, from papilliferous carcinoma and one endothelioma, with histories extending over several years, to a suppurating sarcoma with a total duration of six months. Two were sarcomata, one was not definitely determined, and the rest were carcinomata.

IV. PRINCIPAL REASONS FOR OPERATION.

Table IV.

Dyspnœa	274	of which 1	died
Discomfort, deformity, and slight dyspnœa ..	99	„ 0	„
Deformity	17	„ 0	„
True exophthalmic goitre	79	„ 3	„
Malignant and papilliferous	13	„ 2	„
Suspected malignancy	5	„ 0	„
Primary chronic inflammation	1	„ 0	„
Palpitation, nervousness, etc.	12	„ 1	„ (glycosuria)
Total	500		

Dyspnœa.—It will be seen by the table that by far the most common and important reason for which operation was undertaken was dyspnœa. I have never declined to attempt the removal of any innocent goitre on account of the mere severity of the dyspnœa; in many of the cases there was a very high degree of dyspnœa; often it had existed for years and led to serious complications such as dilatation of the heart, tachycardia, and chronic lung complications. Many of the patients were quite unable to lie down, and had to be operated upon in the semi-recumbent position. In the great majority of cases the dyspnœa was not so extreme, although practically always enough to cause the patient considerable distress. In this series there has been no such theatrical case as that of the girl, age 14, upon whom in 1901 I had to do a hurried bilateral extirpation as she lay in bed, quite unconscious from impending suffocation, which had supervened suddenly in the middle of the night.* On the other hand, I have to record an unfortunate case which is not in this series, although it ought to have been, and I wish it had been. It was that of a man, age 20, admitted to the Royal Free Hospital, Feb. 3, 1914, with a large soft parenchymatous goitre of five years' duration, which for eighteen months or more had caused gradually increasing dyspnœa. It was thought that he would improve and be in a better condition for operation after a day or two of rest in bed, as such cases usually are. He passed a fairly comfortable night, but in the early morning sudden suffocation occurred, and he was dead before even the house surgeon could reach him. In this case it was an error of judgement on my part not to have operated directly I saw the patient, in which case I should doubtless have saved his life. The goitre, which is seen from behind in *Fig.* 287, was symmetrically bilateral and purely parenchymatous, the lateral lobes just meeting behind the pharynx and œsophagus. The trachea was compressed

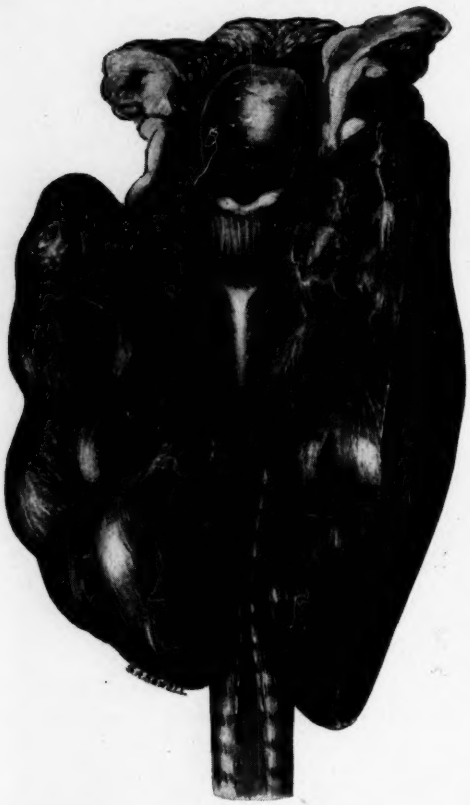

Fig. 287.—View from behind of a large parenchymatous goitre with larynx and trachea, showing the usual scabbard shape of compressed trachea. From a man with chronic dyspnœa, age 20, who died of suffocation suddenly in his bed, before any operation had been attempted.

* *Case* 136, *Lancet*, 1902, i, 1227, and *Proc. Roy. Soc. Med.*, 1907, Nov. 12, 39. This patient has recently been seen by me and is in excellent health.

laterally in the usual manner for nearly 2 in., the lumen being a mere chink. The goitre, after removal from the body together with the larynx and trachea, weighed 26¾ oz.

In no case during this period of seven years have I performed a tracheotomy for innocent goitre, holding as I do very strongly that removal of the source of pressure, namely the goitre, is a far more satisfactory proceeding than mere tracheotomy. There are, of course, cases in which the operator, owing to circumstances which preclude the possibility of doing a clean thyroidectomy, may be compelled to attempt a tracheotomy under conditions of extreme urgency.

Tracheotomy for suffocating goitre is apt to be a difficult proceeding, and far more dangerous to life, owing to septic complications, than a clean thyroidectomy performed under proper conditions. The trachea is often deeply buried under the mass of goitre; it may be much displaced and difficult to find; the constricted region of the trachea may be, and often is, behind the sternum. The dyspnœa of goitre being due, not to spasm of the larynx, but to direct pressure upon the trachea, is not relieved by merely opening the larynx or the upper part of the trachea. It is generally quite impossible to reach the trachea below the constriction, and if the trachea be opened above it, an unusually long tube (such as Koenig's), which is not always at hand, must be employed. Our museums and surgical literature abound in illustrations of futile attempts to perform tracheotomy under such conditions. When it has been successfully performed, the mortality is considerable, and the patient still has the goitre pressing upon his trachea.

In cases of high degree of dyspnœa the operator will nevertheless do well to have tracheotomy dilators and a long tube at hand in case he may have to use them during the performance of the operation. There have been awkward moments during many of the more severe of my operations, especially during the dislocation of the tumour, when it has seemed that tracheotomy might become necessary. Even after the goitre has been removed, there is sometimes a danger of tracheal collapse. I have occasionally had to watch a flattened trachea for some little time after removal of the goitre before I ventured to close the wound over an unopened trachea. Fortunately many of the most severe cases of acute dyspnœa occur in young subjects with bilateral compression, in whom the trachea still retains much of its normal elasticity. In such cases the flattened trachea very quickly recovers from its compression. In older people recovery is much more slow, but the degree of compression is usually not so great.

An important point may here be insisted upon, which is, that in the case of bilateral compression of the trachea, the removal of one lobe alone may be quite insufficient to relieve the dyspnœa, indeed may even make it worse. The bilaterally-compressed scabbard-shaped trachea, so long as it remains in the middle line, may permit the passage of sufficient air to keep the patient alive. But remove one lobe, and the opposite lobe immediately pushes the trachea away from the middle line, bends it, and produces a kink which may easily lead to a fatal suffocation.

I would venture to lay down a rule that in cases of bilateral goitre with high degrees of dyspnœa, it is often dangerous to be content with a unilateral operation. After one lobe, or the major portion of it, has been removed, the operator should always examine the condition of the trachea and of the opposite lobe very carefully, and be prepared if necessary to remove also the lower portion of the latter. Much depends naturally upon the degree of stenosis, and the skill and judgement of the operator.

Another point with regard to dyspnœa which is sometimes overlooked, but which is of much practical importance, is this, that it is by no means the most prominent or the most obvious portion of the goitre that is the real cause of the dyspnœa. There are many cases in the present series in which an obvious, prominent, apparently unilateral goitre was considered by the patient, and sometimes even by his doctor, to be the cause of the severe dyspnœa from which he was suffering. Nevertheless in these cases it has often been the *opposite* lobe that has been the real offender, and which is the one that requires removal, lying deeply, perhaps even wholly unsuspected, behind the sternum or in the thorax. The key to the position in such cases is to be found in a careful examination of

the root of the neck, where the top of the offending mass can often be felt ; or in observation of the exact position of the trachea, displaced away from the source of pressure. In some cases an *x*-ray examination, if it can be obtained, may be most useful, showing as it may do, not only the deeper portion of the goitre, but the position of the trachea, which shows up as a band of light in the skiagram. An inexperienced operator may easily remove the wrong half of the goitre.

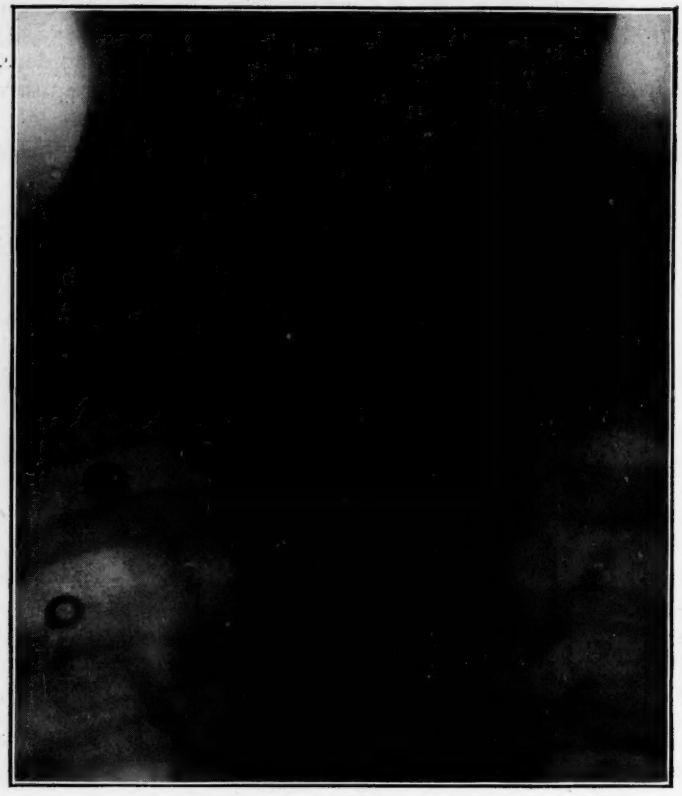

FIG. 288.—No. 1338. Skiagram of a comparatively small left-sided, almost wholly intrathoracic goitre, showing the trachea, which appears as a band of light, displaced to the (patient's) right. In the neck a right-sided goitre bends trachea slightly to left in an S shape. M., age 54. (*See also* FIGS. 289 and 290). Skiagram was taken the day before removal of the intrathoracic portion, which weighed 6 oz.

If a parenchymatous goitre in a young subject—that is, a goitre uniformly enlarged in all parts—presents one lobe which is much more prominent than the other, it is nearly always the *least* prominent, that is the deeper, lobe that most urgently demands removal. Similarly in older subjects, if a large rounded prominent mass fairly high up in the neck is accompanied by serious dyspnœa, it will often be found that the true cause of the dyspnœa lies in an enlargement of one or other inferior horn which lies jammed in the upper opening of the thorax. A typical example, from among many, may be cited.

A retired merchant, age 70, was sent to me in 1918 with a history that for several years he had had some difficulty in breathing, together with tachycardia. Both symptoms had become much worse in the last few months. Recently he had been treated for 'heart disease' in a nursing home for twelve weeks without much benefit. A *right*-sided goitre as large as a hen's egg, fairly high up in the neck, was then supposed to be the cause of his trouble, and it had been suggested that the removal of this would benefit him. When, shortly afterwards, he came to me, it was obvious that the real cause of all his trouble was an old *left*-sided goitre jammed in the upper opening of the thorax. The top of this could easily be felt when the head was extended and the goitre thus drawn up. His heart, examined for me by Dr. Strickland Goodall, showed the usual dilatation so often seen with chronic goitre, extreme irregularity, and auricular fibrillation. After

FIG. 289, *a* and *b*.—No. 1338. Bilateral goitre, right side cervical, left side almost wholly intrathoracic. M., age 54, who had suffered for some years from increasing paroxysmal dyspnœa. (*a*) Condition when at rest. (*b*) Condition when straining, the top of the intrathoracic portion then rising into the root of the neck.

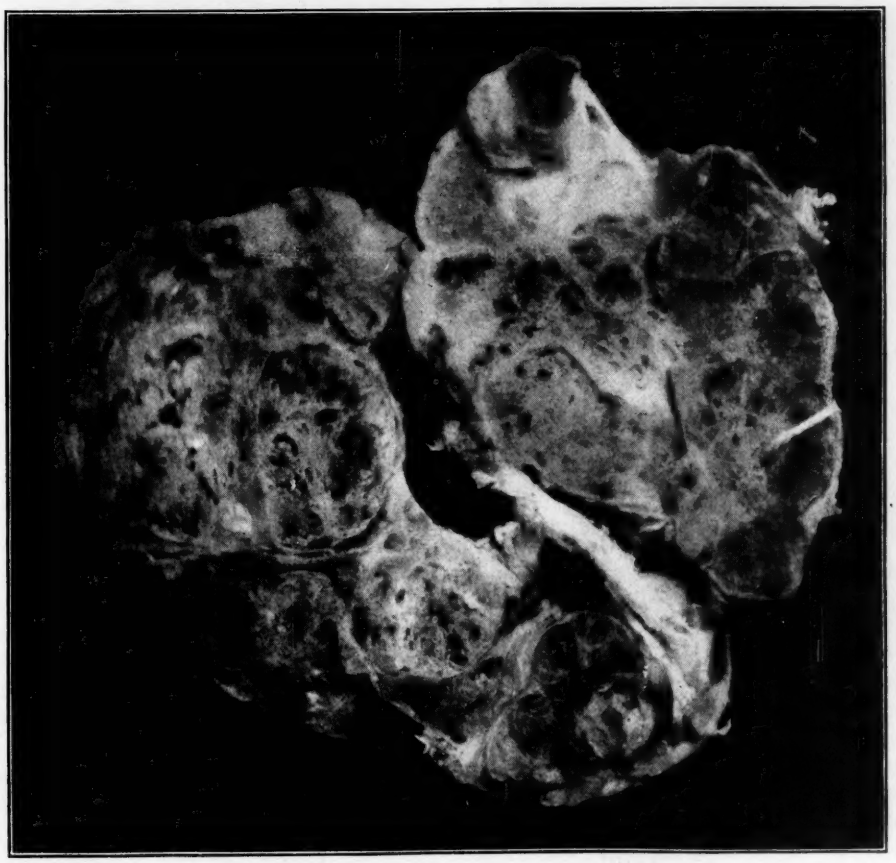

FIG. 290.—No. 1338. Left-sided intrathoracic tumour removed by extirpation from the preceding. Adenoparenchymatous, with some calcification of lower horn. Weight of intrathoracic portion 5½ oz.

giving him a few days' rest in bed in a nursing home and some treatment with digitalis, I removed the left-sided intrathoracic goitre, about as large as an orange. It had evidently been there for many years, as it was largely fibrotic. The recent enlargement was due to the accumulation of some fluid within it. The patient made a rapid recovery, and was able to leave the home a fortnight after the operation, with his wound soundly healed. His heart gradually recovered its tone, and he is now in good health with a regular quiet pulse. He is able to rush about the country and make long political speeches without effort.

Discomfort, Deformity, and Slight Dyspnœa.—In this group, which comprises one-fifth of all the cases, are included those in which the goitre, mostly unilateral, was removed partly on the ground of discomfort produced by pressure, and partly because of the deformity, often very considerable. Really severe dyspnœa was not present in these cases, although in many of them the steady growth made it probable that serious dyspnœa would occur later if no operation were undertaken. In most of them slight dyspnœa occurred on exertion, and many had other symptoms such as tachycardia, palpitation, dysphagia, and various nervous symptoms. It was noticeable that many of these patients, who before the operation had not complained of dyspnœa, volunteered afterwards the remark that they could breathe much better than before. A large number also stated that, besides enjoying freedom from local symptoms, their general health had improved very much. Those who were below the normal weight before the operation—and most patients with such goitres are thin—usually regained it afterwards. In this group comes the patient from whom the largest goitre in the whole series was removed. He was a young man, age 21, who had had for several years a gradually enlarging parenchymatous goitre which caused him much discomfort, mainly from its bulk and weight. Nearly the whole of the right lobe, together with four-fifths of the left, were removed without difficulty. The total weight of the parts removed was 3 lb. $0\frac{3}{4}$ oz. (R. $27\frac{1}{2}$ oz., L. $21\frac{1}{4}$ oz.). He made a rapid and excellent recovery, and was subsequently for three years on active service in the army, which he has only recently quitted. *Fig.* 291 shows his condition some three or four years after the operation.

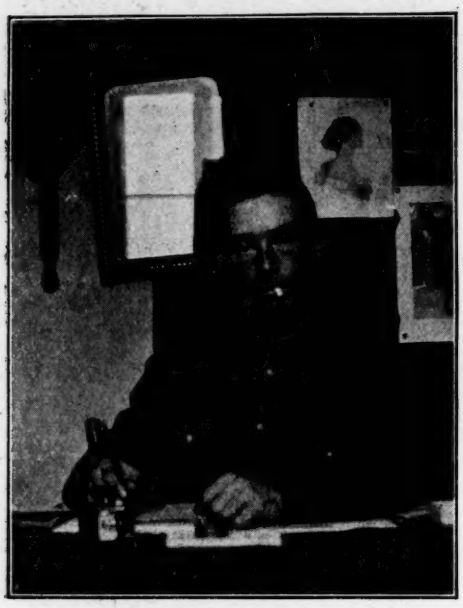

FIG. 291.—No. 1019. Patient, age 24, about 3 years after bilateral extirpation for discomfort, bulk, and weight, of a parenchymatous goitre weighing 3 lb. and $\frac{3}{4}$ oz. (The largest of this series.)

Deformity.— In 17 cases only was the operation done mainly for deformity (hospital cases 5, private 12). Two patients were men, the rest women. All except four were under 40 years ; of these, one was a man, age 50, with a very unsightly lump as big as a golf-ball, situated directly in front of the larynx ; the other a man, age 73, with a very large mass which weighed 22 oz. after removal. All the tumours were unilateral, and most were of various sizes from that of a walnut to that of a goose's egg. In all cases the wounds healed by primary union, and the patients were all quite well when last seen or heard of, one only three months, the rest from two to seven years, after the operation. Operation is never performed for mere deformity for small or moderate-sized parenchymatous goitres. Such cases are best treated by medical means, which should include a search for, and if possible removal of, the primary source of trouble.

True Exophthalmic Goitre.—The reason for operation in all these cases was the existence of well-marked clinical symptoms of Graves' disease, and not the presence of the local trouble. Marked dyspnœa was not present in any case, and even slight dyspnœa was wholly absent from most. It is not necessary to dwell further upon the well-known

symptoms of the disease, to which, moreover, allusion has already been made in the preceding section.

Malignant and Papilliferous.—In this class have been placed together, for convenience, all cases which were proved to be of this nature, although the principal reason for the operation was not necessarily a definite diagnosis of malignancy. In one case of a large solid adenocarcinomatous tumour, for instance, dyspnœa was the primary cause of the operation; in another it was pain; in the third it was the presence of spontaneous suppuration that demanded operation. Out of a large number of cases of malignant disease seen during the period, only twelve cases were submitted to operation. One case of papilliferous carcinoma underwent two operations.

Suspected Malignancy.—The 5 cases of this group were all elderly people (3 women, 2 men), whose ages were from 46 to 61. All had comparatively small tumours, with a history, sometimes afterwards proved to be erroneous, of short duration. None were definitely diagnosed as malignant; indeed in none was it thought that malignancy was very likely to exist. But in each case there was some point which made it very difficult to say that the case was not one of an early stage of malignancy, and it seemed better to subject the patient to the trivial risk of a small and easy operation rather than to leave the tumour, especially as all the patients were alarmed and anxious for operation. In one case it was paralysis of the sympathetic nerve and slight dysphagia, in another unusual hardness and irregularity, in another a small hard lump at the back and inner part of the gland causing discomfort and pain, in the other two hardness with very short history, that led to the operation. All made excellent recoveries and are known to be quite well at the present time.

FIG. 292.—No. 1275. Solid adenoma showing the common star-shaped central fibrous mass, with commencing calcification. Weight 9¼ oz. F., age 43. Removed on account of discomfort and slight dyspnœa. (*R. Free Hosp. Mus.—Ca. Cg.* 9030.)

During the same period many cases have been sent to me with a diagnosis or a suspicion of malignancy in which I was able to state definitely from the physical characters of the tumours, and the history, that the disease was non-malignant and that no operation was necessary. In none of these cases, so far as I am aware, did malignancy subsequently develop.

There is another important class of case, however, that deserves special mention. It is not uncommon for an elderly patient with a large, often bilateral, hard, and somewhat fixed goitre to give an indefinite history of the occurrence recently of symptoms such as slight pain, slight enlargement, or some vague feeling of discomfort which raises a suspicion, but merely a suspicion, of the supervention of malignancy. In such cases, in the absence of any of the more definite signs of malignancy, such as recurrent laryngeal

paralysis, marked dysphagia, adhesion to neighbouring structures, etc., it may be impossible to say more than that the disease may possibly be malignant. In such cases of elderly patients whose general health is quite good and who are not suffering from any local trouble due to the goitre, it is generally unwise in my opinion to subject them to what must necessarily be an extensive and severe operation which will probably prove to have been quite unnecessary. Frequently the symptoms are due to the development of a small cyst or a little hæmorrhage in the depths of the tumour, for which it is quite unnecessary to do any large operation.

In a certain number of such cases there may really be malignant disease, and, if it could be diagnosed with certainty, even a large and dangerous operation would be quite justifiable. The treatment must depend upon the judgement and experience of the individual surgeon, the severity of the proposed operation, and the probability of the patient being really benefited by it. For it must not be forgotten that sometimes very extensive malignancy exists without any pain or any of the other ordinary clinical manifestations. The disease may be found to be wholly inoperable owing to infiltration of the deeper structures, while the patient's general health is still perfectly good. To operate on such a case often means putting the patient at once into a condition of grave discomfort and danger from which he will probably never recover. If not operated upon, he may enjoy many months or even a year or two of comparative health and comfort.

FIG. 293.—No. 1256. Left lobe bilateral adenoparenchymatous goitre showing extensive central calcification. F., age 47. Partial bilateral extirpation for increasing bulk and discomfort. Weight 12½ oz. (*R. Free Hosp. Mus.—Ea. Cg.* 9035.)

A very important point to consider before undertaking an operation for the removal of a supposed undoubted malignant goitre is whether the gland moves, not only on swallowing, but *also upon the larynx and trachea*. Many a malignant goitre which moves quite freely up and down with the larynx and trachea will be found at the operation to be so hopelessly incorporated with the trachea, and possibly also with the œsophagus, as to render satisfactory removal out of the question and the operation perfectly futile. On many occasions I have known want of attention to this point to have induced young surgeons (including myself, in the past) to embark upon useless and unjustifiable operations which had much better not have been attempted.

Out of many cases that illustrate the above points I will cite briefly two :—

Case 1.—In March, 1919, a lady, age 72, who had had a goitre for at least twenty-five years, was brought to me because she thought that in the last three months it had grown a little larger, and had caused a little discomfort. There was no loss of flesh, no dysphagia, dysphonia,

or dyspnœa, nor any other certain sign or symptom of malignant disease. The thyroid presented itself as a very hard bilateral mass low down in the neck, each lobe being as large as a hen's egg. The mass moved freely with the larynx and trachea, but could not be moved freely upon the trachea. I told the doctor that there was a very strong suspicion of malignancy in this case, although I could not be absolutely certain, as there was no definite evidence of the tumour having altered in size or consistency for many years, and that it was *possible* that it might be merely an old calcified or fibrotic goitre of long standing. What was quite certain, however, was that " whatever it is, no operation is desirable : if it is malignant, operation is out of the question on account of the extent of the disease; if it is non-malignant, no operation at all is necessary ". Two months later the tumour was a little larger, but the feeling of discomfort had almost gone. The diagnosis of carcinoma was now fairly certain. From time to time I heard of her, that she was able to get about and enjoy life, but that the tumour was slowly growing, although causing no fresh symptoms.

In October, 1920, nineteen months after I first saw her, she was brought to me again. She was still able to get about, and was not suffering to any great extent. The tumour had now grown to the size of a man's fist. It was irregularly hard and knobby ; the carotid artery was not palpable. There was still no dysphagia or dyspnœa, but there was a little irritative cough. The general condition was still good, but the patient was pale, and it was evident that she was beginning to fail. I heard from her doctor recently that a few weeks later she got very rapidly worse, and that she died just a week ago, 21 months after I first saw her, without having had any serious suffering or discomfort until within the last few weeks. The post-mortem showed an extensive carcinoma.

On the other hand, a year later, in March 1920, an almost exactly similar case was brought to me by another doctor.

Case 2.—This patient was a lady, age 59, who had had a bilateral goitre for many years—at least seven—and, according to her husband, probably about twenty years. For about three months she had complained of some laryngitis and cough, but she had no pain, dysphagia, or dyspnœa. Both lobes of the thyroid were enlarged, on one side to that of a hen's egg, on the other to twice that size ; as in the previous case, the tumour was low down in the neck ; it moved freely with the trachea, *but not upon it.* The carotid artery could easily be felt on one side but not on the other. This was the most definite point in favour of malignancy. As before, the diagnosis lay between old adenoparenchymatous goitre and malignancy supervening upon an old innocent goitre, although in this case I was inclined to take a somewhat more hopeful view of the case, in spite of the condition of the carotid artery. My notes record that " if the tumour is malignant, curative operation is out of the question; if innocent, the symptoms are not bad enough to demand operation ". It was arranged that she should see me again in three months' time, or sooner if necessary. Before the expiration of that time, however, I heard that she was dead. On making inquiries, I learnt that, upon the advice of a friend, she had subsequently consulted another surgeon who had been bold enough to advise and to attempt removal, which was performed six weeks after I saw her. The doctor has kindly given me a full account of the operation, which presented great difficulties. " Owing to the isthmus being very adherent, in raising this, the trachea got torn . . . . a fœtid bronchitis supervened ", and the patient died of this six weeks later. The removal was stated to have been " probably incomplete ". It is only fair to add that I am informed that in the interval which elapsed after I saw the patient dyspnœa seems to have developed, and some such operation as tracheotomy may have been desirable. But on the other hand the condition, which was hopelessly inoperable as regards any prospect of cure when I saw the patient, is not likely to have been any more favourable six weeks later. The case is one which young and confident operators will do well to remember.

Primary Chronic Inflammation.—The case showing this condition has already been fully described in *Section III.*

Palpitation, Nervousness, etc.—The 12 cases included in this class are instances of what, for want of a better term, I am in the habit of calling 'false' exophthalmic goitre. They are very common. Many others presenting similar symptoms might also have been placed here, but have been put under dyspnœa, or elsewhere, since this was the main reason for the operation. These cases, although often classed as 'exophthalmic goitre', ought, in my opinion, not to be so called. They do not develop exophthalmos, although they may present nearly all the other symptoms of that disease ; the gland after removal does not present the appearances characteristic of that disease. What is still more important, operations upon them do not carry with them the same risk, or anything approaching the risk, of the operation for true Graves' disease.

I am not speaking of the so-called Basedowified goitre, cases in which to an old simple goitre have been added all the signs and symptoms of true Graves' disease. Such cases,

in my experience not very common, are really cases of true Graves' disease, and are accompanied not only by exophthalmos, but by the characteristic pathological appearances of that disease, which are seen in the gland side by side with the evidence of the old pre-existing goitre, whatever its nature.

The cases in the class which I am now describing are ordinary goitres, generally unilateral, often simple adenomata or cysts, sometimes parenchymatous, but which do not present exophthalmos or the pathological appearances of Graves' disease. The term 'thyrotoxic' adenoma is often applied to them, but I am not at all sure that the theory which this name implies is a correct one, although it may be. What is important clinically is that the removal of the tumour, which is generally a simple operation, and practically as safe as that for ordinary goitre, will usually result in the patient quickly losing all her unpleasant symptoms and being completely restored to health, which is by no means always the case after operations for true exophthalmic goitre.

There are, of course, exceptional cases which are difficult to classify, especially in the early stages, but on the whole the three groups that I have mentioned are fairly well defined and easily separable from each other.

The following may be cited as a typical example of the class of 'false' Graves' disease :—

No. 957.—Mrs. H., age 35, had had for ten years a right-sided goitre, and for five years had been subject to palpitation. She had had no serious dyspnœa, but had lost weight considerably of late. There was no exophthalmos, and she had not had diarrhœa. The heart was slightly dilated and the pulse quick and irregular.

In July, 1914, the tumour was removed by resection-enucleation without any difficulty. It was an ordinary encapsuled adenoma as large as a hen's egg, and weighed 2¼ oz., five-sixths solid, the rest consisting of clear fluid. The pathological examination showed no signs of true Graves' disease. The wound healed by first intention, and the patient went home on the nineteenth day after the operation. When seen again two months later she both looked and felt much better. She had gained weight and lost her palpitation, although she still had some tachycardia and slight cardiac irregularity; she stated that her heart gave her less trouble than before. In September, 1920 (six years later), her husband writes me from the country that "the operation was a complete success, as she has not had signs of any trouble since".

V. NATURE OF OPERATION.

Table V.

Extirpation	190	
Resection-extirpation	119	
Extirpation and enucleation	4	
Extirpation and resection-enucleation	1	
	—	314
Enucleation	13	
Resection-enucleation	168	
Resection-enucleation and enucleation	5	
	—	186
Total		500

Operations performed:—Right side	252	
,, ,, Left side	135	
,, ,, Bilateral	83	
,, ,, Right side and isthmus	21	
,, ,, Left side and isthmus	8	
,, ,, Not known	1	
Total	500	

Of the figures in this table it is not necessary to say much. It will be seen that the extracapsular operations of extirpation and its varieties greatly exceed the intracapsular operation of enucleation and its varieties. Among the latter it will be noticed that pure enucleation is now but rarely performed, having been almost wholly superseded by the much better operation of resection-enucleation, in which the thinned and degenerated

layer of glandular capsule is removed together with the tumour (*Fig.* 295). This leaves behind a much smaller surface of wounded gland.

One sometimes hears surgeons speak of the ' shelling out of a *lobe* ', in my opinion a most dangerous proceeding. The principal danger of the shelling out (enucleation) of even an encapsuled tumour, to which alone this operation is applicable, is that of penetrating the posterior, and often very thin, layer of investing glandular capsule, and causing serious venous hæmorrhage or damage to the recurrent laryngeal nerve. If the shelling out of a whole lobe—that is, an extracapsular operation—were attempted, it would be scarcely possible to avoid most serious venous hæmorrhage. Pure enucleation is now reserved almost entirely for cases of quite small and superficial encapsuled tumours enclosed in a relatively thick layer of fairly healthy thyroid-gland tissue. If this table be compared with the similar table in which I gave, in 1913,* the statistics of my previous series of operations (Nos. 401–751), it will be seen that in the earlier series the enucleation class of operation comprised four-sevenths of the total number, while in the present series it comprises only a little over one-third. In other words, intraglandular operations are being replaced more and more by extracapsular ones, but these are never ' shelling-out ' operations.

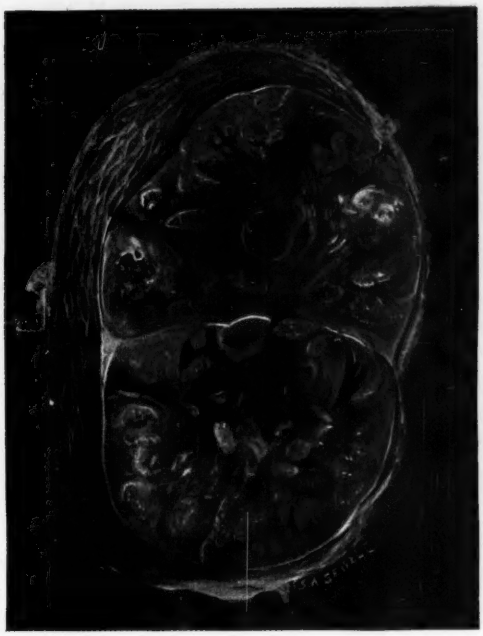

FIG. 294.—No. 223. A well-encapsuled solid adenoma (fœtal type) covered by thick layer of compressed but otherwise fairly normal gland-tissue. F., age 36. Removed by resection-enucleation.

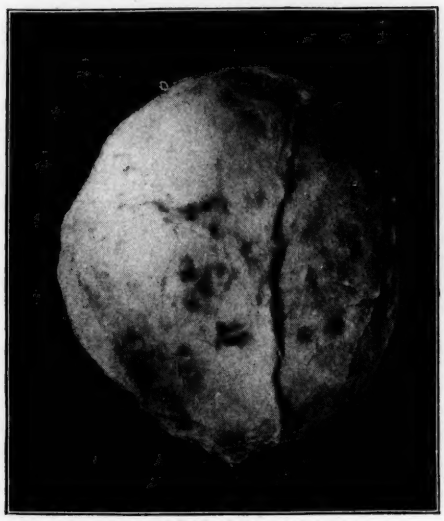

FIG. 295.—Encapsuled solid adenoma after removal by resection-enucleation. Surface of tumour proper is seen on the right, that of thin investing layer of thyroid gland on left.

Total extirpation of even one whole lobe is, however, now but rarely performed by me, except for malignant disease, and in a few other exceptional cases.

A portion of gland, usually about as large as a normal lobe, is practically always left at the hilus, or ' dangerous area ' as it has been called. I consider this to be a great improvement on earlier practice. Total removal of the whole thyroid gland I have never performed in the whole of my practice. I consider it to be an entirely unjustifiable proceeding, never necessary even for malignant disease, and still less for exophthalmic goitre.

The combined operation (e.g., extirpation and enucleation) refers of course to the different treatment of the opposite sides of the gland at the same operation.

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* Lettsomian Lectures. *Trans. Med. Soc. Lond*,, vol. xxxvi.

VI. INTRATHORACIC GOITRE.

Table VI.

Patients	22
Operations	22
Males (average age 51 years)	8
Females („ „ 46 „)	14
Unilateral operations	17
Bilateral „	5
Parenchymatous	6
Adenoparenchymatous	11
Solid adenoma	4
Cystic „	1
Weight in oz. or size (male)	Orange, orange, 12, 9¾, orange, orange, 8, 4
„ „ „ (female) ..	?, ?, 11½, 8, 3¾, ?, 7½, 28, 6¾, 5, 7, 6¼, 12, 12
Primary union	17
Sinus—few days to few weeks	5
Complete recovery	22

As a general rule it may be stated that the lower down in the neck a goitre is situated, the more likely it is to produce serious or dangerous dyspnœa. Many goitres, especially unilateral ones, are situated behind the inner end of the clavicle or upper border of the sternum, and becoming jammed between these parts and the projecting vertical column, displace and flatten the trachea obliquely, thus causing severe dyspnœa. To these the terms retroclavicular and retrosternal* goitre may be applied.

But in many cases the goitre descends still lower, below the level of the first ribs, thus lying partly or even wholly within the thorax proper. If enlargement and consequent tracheal pressure take place in this situation, the term *intrathoracic* is applicable.†

FIG. 296, *a* and *b*.—No. 893. (*a*) Solid unilateral, mainly intrathoracic, goitre, the upper part of which rises into neck. F., age 65. (*b*) Side view. Removed by resection-enucleation on account of dyspnœa and œdema of the arm. Note the distention of the veins of the neck.

The goitre may be wholly intrathoracic or only partly, the upper part forming an obvious swelling in the neck (*Fig.* 296). Any kind of goitre may be intrathoracic, but in the great majority of cases the goitre does not become intrathoracic, or at any rate is not diagnosed as such, until the patient has reached middle age. Adenomata, cysts, and

* The term retrosternal or substernal goitre is also applied by many authors to goitres situated still lower down, behind the manubrium or body of the sternum; for these I prefer the term intrathoracic.

† It is quite common for the tip of one or both inferior horns of a goitre to descend for a short distance into the thorax, but without causing pressure in this region—such cases are, of course, not included among the intrathoracic goitres.

other more or less encapsuled masses in connection with old adenoparenchymatous goitres are therefore much more common than the purely parenchymatous form. Occurring thus in elderly people, most intrathoracic goitres have undergone a good deal of secondary degeneration, fibrosis, calcification, etc., which is in one respect a fortunate

FIG. 297, *a* and *b*.—No. 893. The same patient as in *Fig.* 296, three months after operation.

circumstance, as it enables the exact shape and position to be more clearly shown by radiography. In only 2 of the 22 patients of this series was the age below 30, while the average age, as will be seen from the table, was much higher. Two patients were over

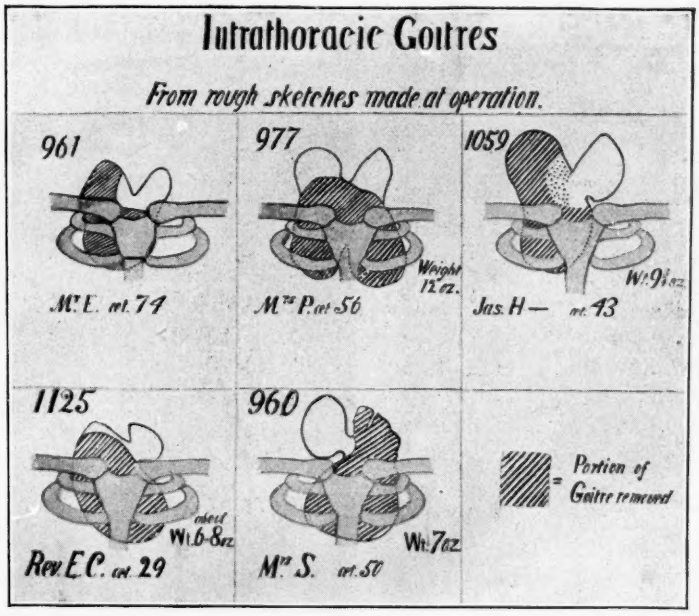

FIG. 298.—Intrathoracic tumours of various kinds. From rough semidiagrammatic sketches made by author immediately after the operations.

70. The large proportion of men (8 out of 22) is noticeable, as is also the fact that no less than 17 out of 22 occurred in private practice. The last point is difficult to explain, unless it be that many of these patients came from distant parts of England (or even from abroad) for operation, and that hospital patients are perhaps more likely to be treated in hospitals nearer their own homes.

Intrathoracic goitres are usually attended with very severe symptoms, both respiratory and cardiac, but especially the former. But if situated entirely within the

thorax and well below the first ribs, they will sometimes produce very few symptoms until they suddenly or gradually enlarge and produce severe pressure symptoms.

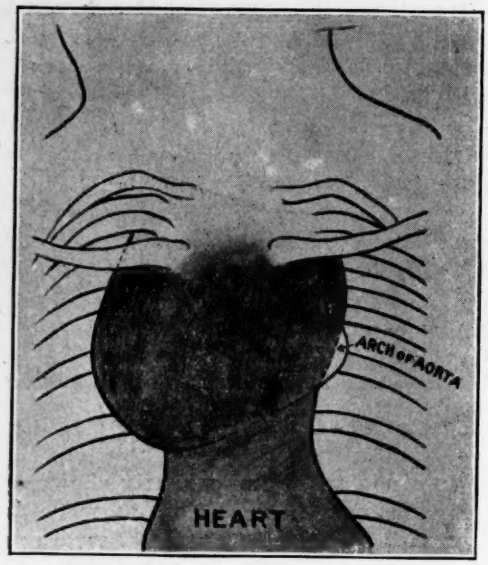

FIG. 299.—No. 779. Semidiagrammatic representation of a double but mainly right-sided, solid, intrathoracic goitre, removed in 1913 by extirpation from a lady, age 64, for dyspnœa. Weight 11½ oz. Taken two days before operation.

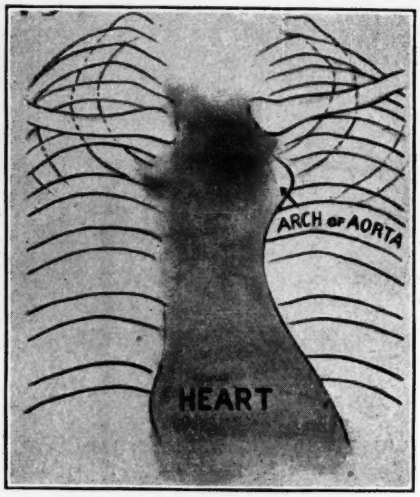

FIG. 300.—No. 779. Semidiagrammatic representation of the preceding three months later, from a tracing of the skiagram, omitting irrelevant details.

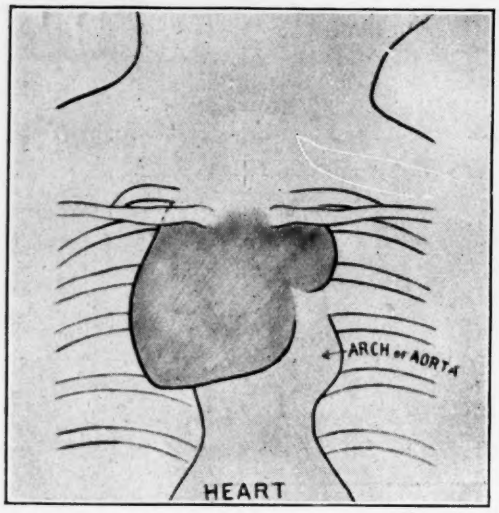

FIG. 301.—No. 1329. Semidiagrammatic representation of a bilateral, mainly right-sided, wholly intrathoracic goitre, removed by extirpation for severe paroxysmal dyspnœa. Taken shortly before operation.

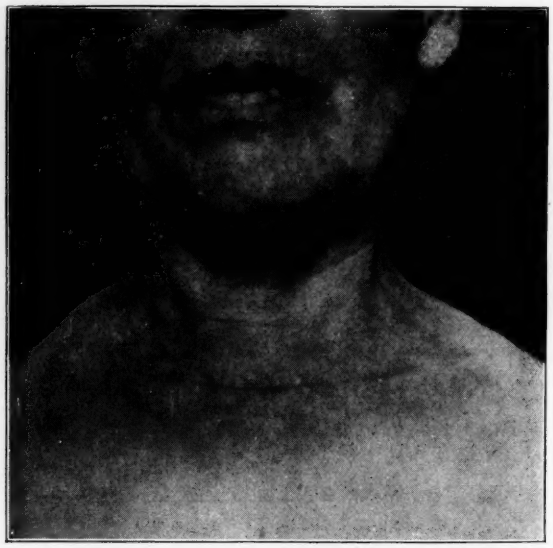

FIG. 302.—The same patient a fortnight later, showing scar of low transverse incision through which tumour was removed.

A very common history is that the patient has had a goitre for years, and that as the goitre became apparently smaller (i.e., became sucked down into the thorax) the dyspnœa (often diagnosed as 'asthma') became worse. It is not uncommon for one side of a bilateral goitre to form an obvious tumour in the neck, while, on the opposite side, lying wholly unsuspected in the thorax, is an intrathoracic goitre which is the real cause of the dyspnœa. A case of this kind has already been cited in *Section IV*.

Intrathoracic goitres, unless parenchymatous in young people (which are very unusual), are but rarely amenable to any kind of treatment short of direct removal by operation. Fortunately, in the great majority of cases these goitres can be removed by a well-executed, although naturally a somewhat serious and difficult, operation. The patients, who have usually suffered extremely from dyspnœa, and whose lives have probably been in great danger from it, are usually only too willing to submit to an operation which offers them a good prospect of complete cure. These operations are among the most satisfactory goitre operations that I have to do.*

The operation depends for its feasibility and success upon attention to the following points: (1) As the goitre grows downwards into the thorax it carries its main vessels with it; consequently none enter it from below upwards. If this were not so, the operation would be impossible. (2) Most of the main veins lie in front of the goitre, and no attempt should be made to extract it until these have been carefully clamped or tied. Frequently it is desirable to free the upper part of the lobe, if this is in the neck, by isolating and tying vessels in the usual manner. When these vessels have all been secured, and the top of the tumour itself has been freely bared, but not till then, the extraction may be attempted. No attempt should be made to pass any instrument down into the chest *in front* of the tumour. But at the back a space will always be found through which it is possible to pass a scoop, or better still an ordinary silver dessertspoon or tablespoon, into the chest, behind and below the goitre. The spoon must have a rounded, not a pointed, lower edge, lest it should leave the surface of the goitre and perforate some adjacent structure such as the pleura, an accident which, however, I have never actually seen. The rounded bowl of the spoon pushes the pleura away from the goitre and facilitates its separation. *Fig.* 303 shows the pattern of spoon that

FIG. 303.—The form of silver spoon used by the author. (*Full size.*)

* In the present series there were no deaths. In the preceding series (published 1913, loc. cit.) there was 1 death among 18 cases. The patient, the skiagram of whose thorax before and after operation was published in 1913 (*Trans. Med. Soc.* xxxvi, 197), still enjoys robust health at the age of 70, eight years after the operation.

I commonly employ.* The position of the recurrent laryngeal nerve must be borne in mind. The spoon must be inserted between this and the goitre. Damage to the nerve is one of the main dangers of the operation, and I have not always been able to avoid it (*see No.* 779, *Fig.* 299).

If the goitre is old and tough, and has a well-marked capsule, several pairs of forceps may be placed upon the front of it and traction made together with a scooping movement of the spoon. If the tumour is partly cystic, so much the better, as the size may be considerably diminished by letting out some or all of the fluid.

If solid and too large to be extracted whole through the upper opening of the thorax, I have sometimes broken up the interior to reduce the size; but this is a somewhat dangerous proceeding, and, if attempted, care must be taken to keep away from the periphery of the tumour where most of the veins lie.

If the goitre is unequally bilateral, the smaller part should always be removed first, to relieve the breathing and to give more room for the extraction of the larger tumour.

The most dangerous moment of the operation is when the tumour is being delivered through the narrow upper opening of the thorax, since it is just at this time that most pressure is exerted upon the already narrowed trachea. As soon as the goitre has been delivered, a long piece of gauze is lightly packed into the thorax so as to fill up the cavity and check any oozing from its walls and to minimize the risk of infiltration of blood into the surrounding tissues.

Patients with intrathoracic goitre often have attacks of paroxysmal suffocative dyspnœa alternating with periods of comparative freedom from dyspnœa. If the patient has an ordinary cold the symptoms are likely to be worse, probably from temporary swelling due to increase of fluid in the tumour. If possible, a period of intermission, when the breathing is least troubled, should be chosen for operative interference.

VII. ANÆSTHESIA.

Table VII.

Year	Operations for Removal	General	Local	General and Local
1913	119	106	12 (11 of these were for exophth. goitre)	1 (1 of these was for exophth. goitre)
1914	136	116	11 (3 „ „ „ „)	9 (8 „ „ „ „)
1915	—	—	—	—
1916	59	59	—	—
1917	—	—	—	—
1918	75	73	2 (1 „ „ „ „)	—
1919	111	108	2 (1 „ „ „ „)	1 (1 „ „ „ „)
Totals	500	462	27 (16 „ „ „ „)	11 (10 „ „ „ „)

Mere ligations of thyroid arteries for exophthalmic goitre have not been included in this paper; for many of these operations local anæsthesia was employed. There were no deaths in connection with any of these operations.

No anæsthetic fatality occurred in any case, either of removal or of ligation.

Having quite recently discussed at some length† the subject of anæsthesia for goitre operations, it is unnecessary here to do more than recapitulate briefly my present views on this subject. Chloroform is never employed now in any of my goitre operations. For

* The use of a spoon I learnt, many years ago, from my friend Dr. Charles Mayo.

† Discussion on "Anæsthesia in Operations on the Thyroid Gland", opened by Dr. May Dickinson Berry, *Proc. Roy. Soc. Med.*, 1920, xiii (Section of Anæsthetics).

general anæsthesia ether is administered by the open drop method on a mask of gauze. Deep anæsthesia is never permitted at any stage of the operation, as in many cases it would be highly dangerous, especially in the earlier stages. The patient should be just sufficiently under the influence of the anæsthetic to avoid pain. In a few cases of a high degree of dyspnœa, local anæsthesia is preferable, especially if the services of an anæsthetist of large experience in this class of operation is not available. In a good many cases of exophthalmic goitre also, local anæsthesia is preferable. But in both these classes of case I am using light general anæsthesia more and more, in preference to local, which is often very distressing to the patient. In some cases local anæsthesia is used at the beginning, and light general anæsthesia in the later stages, of the operation.

Of intratracheal anæsthesia, which is much praised by some, I have no personal experience. It can doubtless be employed with safety in a large number of ordinary goitre operations. But in just those cases in which it would at first sight seem to be useful, I hesitate to employ it, on account of its danger. I have heard of several cases where death occurred during or shortly after its employment for goitre operations, or in which death has occurred during the attempt to employ the method. The necessity of anæsthetizing the patient in the ordinary way before the intratracheal tube can be introduced, the necessary hyperextension of the head, and the occasional failure to get the tube past the point of obstruction in the trachea, are all serious objections which have been well pointed out by Crotti in his recent excellent book on thyroid surgery.* To these I would add that, in the case of a trachea already partly narrowed, the addition of even a very little inflammatory swelling set up by the mechanical irritation of the tube, however soft, might readily increase the post-operation risks. Crotti, an operator of large experience in goitre surgery, remarks that the method of "intratracheal insufflation anæsthesia in thyroid surgery seemed at first to be full of promise. I have, however, found it disappointing. Just in the cases where it was expected to be the most useful, namely in goitres with pressure symptoms, it failed to fulfil its expectations". He mentions no less than three cases in his own practice in which, when sudden unexpected dyspnœa occurred, he failed to introduce the tube into the trachea. In ordinary cases without much tracheal stenosis, it seems to me to possess no great advantage over simpler methods; and certainly patients sometimes complain much of laryngeal discomfort after its employment, although possibly this is less when the anæsthetist is highly skilled in the technical details of the method.

VIII. DRAINAGE.

This has been employed in all but 7 of the 500 cases; these seven were all small, short, and easy operations. After all large goitre operations, there is a good deal of blood-stained serous discharge, often mixed with colloid, especially in cases of parenchymatous goitre where a considerable surface of wounded gland has been exposed; it is better that this should pass out into the dressing rather than accumulate in the wound or pass into the surrounding tissues, and thus possibly hinder the smooth healing of the deeper parts of the wound. The drainage tube is always of glass and quite short, reaching to just below the plane of the infrahyoid muscles. A longer tube is apt to cause irritation and discomfort. The drainage tube is nearly always removed on the day following that of the operation.

The space beneath the large flap of skin and platysma is not drained, but in many of the more recent cases in the series half an inch at each end of a long skin incision has been left unsutured, to facilitate the escape of any fluid which might otherwise collect under this flap. The flexed position in which the head is kept for a day or two after the operation obviates the necessity for suture at these two points.

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* *Thyroid and Thymus*, 1918. Philadelphia and New York: Lea & Febiger.

IX. HEALING OF WOUNDS.

Table VIII.

Primary union	442
Primary union except in track of drain; healing in few days to few weeks	34
Apparent primary union; mild suppuration after leaving hospital or home*	6
Secondary union after gauze drain or pack	8
Persistent small sinus; healing 3 to 6 months	3
	493

* All healed except one malignant case.

It will be seen from the above table that in the great majority of cases the wounds healed smoothly per primam without any trouble at all. Of the 34 cases in which primary union occurred everywhere except in the track of the drain, some were cases in which some accumulation of blood-stained serum took place either in the deeper parts of the wound or, much more often, beneath the skin flap. In such cases the prompt insertion of a closed pair of forceps for an inch or two into the wound is sufficient to let out the fluid, and no further trouble ensues. Occasionally the track of the drain is mildly infected, presumably from the skin surface or from some fault in the technique; none of these cases were seriously infected.

The eight cases of secondary union were mostly those in which the occurrence of a subcutaneous hæmatoma necessitated partial reopening of the wound and superficial packing with gauze for a few days.

One (No. 776) was that of a girl from whom one lobe (as large as a goose's egg) of a parenchymatous goitre had been removed on account of dyspnœa: recurrent hæmorrhage occurred three hours after the operation: the whole wound was promptly opened up; a small bleeding vein was ligated and the wound lightly packed with gauze for a few days; the patient made a good recovery without any further trouble, and left the hospital on the twenty-first day after the operation.

Details of another case follow.

This was a very remarkable case, that of a lady, age 60, from whom I had, in 1896,* removed the right and most of the left lobe of a deeply seated, partly substernal, parenchymatous goitre, for dyspnœa. The parts removed weighed 11¾ oz. The operation was a very severe one, and was followed by mild suppuration and a sinus which did not heal for eight months, but she made a good although slow recovery, and remained quite well for many years. The remainder of the left lobe, however, had been gradually enlarging, and eventually caused such severe suffocative attacks that she came back to me for further operation. In July, 1914, eighteen years after the first operation, I removed a mass as large as her fist from behind the sternum and left clavicle. The operation, which was performed under local anæsthesia, was long and difficult owing to the existence of numerous old adhesions; the large cavity with unusually rigid walls had to be plugged with gauze, on account of deep-seated venous hæmorrhage from some vessel in the neighbourhood of the left innominate. She was apparently making a satisfactory recovery, when quite suddenly, twenty-eight hours after the operation, she became completely unconscious, with stertorous breathing and paralysis of all her limbs. It was thought at first that she was dying of cerebral hæmorrhage or an extensive sudden thrombosis. Her pupils were not contracted, and there was no evidence that she had taken any drug. Dr. J. A. Ormerod, of the National Hospital for the Paralyzed, saw her with me, and was unable to arrive at any definite diagnosis, but thought, as I and others did, that she was not likely to recover. However, after remaining unconscious for three days, she began to recover rapidly, and in less than a month lost all traces of her paralysis. The wound remained clean and healed very slowly by granulation in the course of about four or five months. She made an excellent and complete recovery, and for the last five years, during which I have frequently seen her, she has been in excellent health, full of energy, and leading an active busy life, in spite of her age. I am quite unable to give any explanation of the nature of this curious complication. The rapid and complete disappearance of all trace of paralysis makes it scarcely possible that there can have been a cerebral hæmorrhage, as was at first thought probable. I have never seen anything like it after any thyroid operation, and it is the only serious non-fatal complication that has occurred after any operation of this series.

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* *Case* 41 published and figured (*Figs.* 119 and 120) in my book on *Diseases of the Thyroid Gland* (1901), at present out of print.

X. DEATHS FROM OPERATION.

Table IX gives brief notes of all the cases that have died as the result, either direct or indirect, of the operation.

Simple Goitre.—No. 757 was a schoolmistress sent to me in 1913 by Dr. W. J. Durant, of Gateshead. In March, 1898, I had removed from her left thyroid lobe an encapsuled adenoma as large as a duck's egg on account of dyspnœa (No. 54). In the intervening fourteen years she had remained perfectly well, but the remaining lobe had recently been enlarging considerably, and an entirely new train of symptoms had supervened within the last year—namely, nervousness, tremor, palpitation, rapidity of pulse, which was persistently at or above 120, and, most important of all, emaciation and glycosuria. She complained of much discomfort and some dyspnœa, and was very anxious for further operation. It was thought to be a case of secondary Graves' disease. On account of the glycosuria, for which Dr. (now Sir) Archibald Garrod kindly saw her with me, she was kept in the nursing home for more than a fortnight, and I then did a resection-extirpation of most of the right lobe, which contained a well-encapsuled adenoma of the common colloid type with commencing cystic degeneration, and weighing 4½ oz. Microscopically the gland showed none of the changes of Graves' disease. After the operation, she soon developed a low form of pneumonia, and of this she died on the twenty-fourth day after the operation. The post-mortem, which was performed by Dr. C. S. de Segundo, who had been attending the patient with me for the pneumonia, showed solidification of one lung, but the mediastinum and root of the neck were quite free from any sign of sepsis, and the wound had healed. The sputum had been examined on two occasions with the following result. "*Films*: A small Gram-negative bacillus, resembling Pfeiffer's bacillus, is present in very large numbers; tubercle bacilli not found. *Culture* (blood agar plates): Influenza bacillus in great majority; pneumococcus also present, with a few colonies of a staphylococcus."

The case appears to have been one of an infection of an old adenoma simulating Graves' disease, as such cases sometimes do, and it would have been much better had I declined to operate upon her. But at that time my personal experience of operations for Graves' disease was comparatively small, and I hoped that an operation would have benefited her.

The only other case in this series in which I have knowingly operated upon a goitre patient with glycosuria occurred ten months later, when I was obliged on account of dyspnœa to operate upon a lady, age 52, although I did so reluctantly. She had been the subject of diabetes for a considerable time, but treatment (by Dr. Risien Russell) had kept the glycosuria fairly well under control. The goitre was an adenoparenchymatous one causing much tracheal pressure. After a week of strict dieting in the home under Dr. Russell, resection-extirpation of the left lobe of the goitre was performed. This case ran a perfectly normal course, and the wound healed by primary union without any trouble, the patient returning home within three weeks of the operation, completely relieved of all her symptoms except the glycosuria. For nearly four years she remained quite well, although still under treatment for diabetes, and I had the opportunity of seeing her on several occasions. Eventually, while on a visit to Scotland, she suddenly developed diabetic coma, and died in less than a fortnight.

No. 925 was a hospital case, a married woman, age 41, in an early stage of pregnancy, sent to me by Dr. Falkner, of Fulham. For many years she had had a large bilateral adenoparenchymatous goitre which in a previous pregnancy, terminating in miscarriage, had caused much trouble. Her temperature was 100° and her pulse 110–112 before operation. As she had considerable dyspnœa, it was thought best to operate upon her at once rather than to wait many months until the end of the pregnancy, during which the dyspnœa would have got much worse. The operation, which involved removal of 10½ oz. from the right lobe and a small portion of the left, was a straightforward one. She got up, as usual, on the day after the operation, and for six days appeared to be doing well. Her temperature then began to rise. The wound was partially reopened in the middle,

Table IX.—DEATHS

CASE NO.	DATE OF OPERATION	PRIVATE OR HOSPITAL	NAME	AGE	NATURE OF GOITRE AND OPERATION
SIMPLE GOITRE.					
757	30/1/1913	Private	Miss K. P.	40	Recurrent solid adenoma. Resection-extirpation right lobe
925	11/5/1914	Hospital	Isobel R.	41	Adenoparenchymatous, right and left .. ..
EXOPHTHALMIC.					
843	20/10/1913	Hospital	James S.	50	Solid exophthalmic goitre. Extirpation right and middle. Local anæsthesia, with a little general.
1076	4/3/1918	,,	Bessie M.	31	Solid exophthalmic goitre. Extirpation right. General anæsthesia
1103	17/6/1918	,,	Lottie B.	37	Solid exophthalmic goitre. Extirpation right (relapse after 2 previous ligations by another surgeon two years previously). Local anæsthesia
MALIGNANT AND PAPILLIFEROUS.					
1048	21/7/1916	Private	Miss J.	54	Recurrent papilliferous carcinoma. Extirpation right with resection common carotid artery and internal jugular vein
1086	30/4/1918	Hospital	Eliz. N.	50	Bilateral adenoparenchymatous and intrathoracic malignant mass

some sepsis having occurred. Symptoms of pleuropneumonia set in, and of this she died four days later. The patient did not miscarry.

This is the only case of the whole series in which any serious suppurative complication occurred.

Exophthalmic Goitre.—The three exophthalmic cases may be taken together. All were bad cases. In two of them there was more loss of blood than usual during the operation. In the other case (No. 843), that of an elderly man, the operation itself, although a very severe one, was not attended with any unusual difficulty. Unfortunately a very small vein which had escaped notice at the time of the operation continued to ooze after the patient returned to the ward. The wound had to be reopened. The bleeding vein was promptly found and tied after only an ounce or two of blood had been lost, but nevertheless he died soon afterwards. All three patients died of sudden heart failure within a few hours of the operation. It will also be noticed that in two out of the three cases the operation was performed wholly or mainly under local anæsthesia. This may be noted by those who consider that the use of local anæsthesia is the main factor of success in operations for exophthalmic goitre.

Malignant and Papilliferous.—No. 1048 was the last of five operations for papilliferous carcinoma. As the long history is characteristic of this class of tumour, it may be given in some detail.

This lady, then aged 43, first consulted me in December, 1905, for a right-sided thyroid tumour which had been present for twenty years but had grown considerably in the last four or five years. In January, 1906, I removed the tumour, which was soft, solid, encapsuled, and as large as a goose's egg. It was thought to be an ordinary adenoma. It recurred and was again removed in 1908 and 1912, the tumours being soft, papillary, and very vascular. On the last of these occasions, definite microscopic evidence of its carcinomatous nature was for the first time obtained (by Dr. Ernest H. Shaw). The tumour at this operation was as large as a man's fist. The fourth operation was in 1913 for a recurrent tumour as large as a hen's egg. In 1915 it had again recurred, but, owing to my absence from England on war service, I had no opportunity of

ROM OPERATION.

WEIGHT OF GOITRE REMOVED	BEFORE OPERATION	AFTER OPERATION
4½ oz.	*Glycosuria.* Pulse 120 to 140. Emaciation	Death from double pneumonia 24 days after operation. No suppuration
11¾ „	Dyspnœa. Pregnant. Temp. 100°, pulse 112	6th day, suppuration. 10th day, death from pleuro-pneumonia
9¼ „	Dyspnœa. Emaciation. Pulse 120 to 124	Recurrent hæmorrhage from very small vein. Death cardiac failure 3 hours after operation.
4 „	Dyspnœa. Restlessness. Pulse 120 to 140	Death cardiac failure 21 hours after operation
4½ „	Mitral regurgitation	Death cardiac failure 11 hours after operation
1¼ „	4 previous operations on same tumour in 11 years	Died soon after operation
—	Extreme dyspnœa. Cyanosis	Died immediately after operation

seeing her again until 1916, by which time it had attained formidable dimensions, occupying most of the right side of the neck. Had it been an ordinary carcinoma, I should not have attempted its removal; but knowing its history and papilliferous nature, and having successfully removed a very much larger one of similar nature from a much older patient in 1908,* I hoped I could again make a satisfactory removal in this case also.†

The tumour was not attached to the trachea, and was cleared without much difficulty above, below, and on either side. But at the back, when it was much too late to abandon the operation, it was found that the main carotid vessels were hopelessly incorporated in the tumour and had to be extensively resected. The tumour after removal weighed 14 oz., and was carcinomatous throughout. Some glands were also involved.

No. 1086 was a case of erroneous diagnosis: it was really a case of intrathoracic malignant disease unconnected with the thyroid, and the goitre operation had little or nothing to do with the death.

The woman had been sent up from a village in Lincolnshire suffering from extreme dyspnœa and with a history of an old goitre which had become much worse lately. When admitted she was livid, sweating, and apparently dying of suffocation. She had a deep-seated bilateral parenchymatous goitre of considerable size low down in the neck; the patient was operated upon as soon as possible under local anæsthesia, becoming completely unconscious soon after the operation had begun. The lower portion of each half of the goitre was rapidly removed without any special difficulty. No relief whatever being afforded, tracheotomy was performed and a long tube inserted, with equally little benefit. Far down in the mediastinum, near the bifurcation of the trachea, a hard irregular mass of growth, evidently malignant, could be felt with the finger. It was obvious then that this intrathoracic growth was the main cause of the trouble, and not the goitre. Unfortunately no post-mortem examination was permitted, and the exact nature of the growth must remain in doubt. Had the patient been able to give a better account of her previous history, or had a more thorough examination of the chest been made, and especially if an *x*-ray photograph could have been taken, no operation would have been done.

*Case published and figured in Lettsomian Lectures, *Med. Soc. Trans.* xxxvi, 198.

† It is but fair to her doctor (Dr. Collard, F.R.C.S., of Croydon), to say that he believed the tumour to be irremovable, and the sequel proved him to be right.

XI. LATE RESULTS OF OPERATIONS.

All goitre patients are asked to report themselves in person or by letter one year after the operation, and most of them do so. Many have been seen yearly. But in the last seven months an attempt has been made to ascertain definitely the present condition of each patient, and *Table X* shows the source of the information thus obtained.* I take this opportunity of thanking all the doctors and others who have been good enough to write to me.

In 30 cases, including of course the few that died, the latest information dates from some period before 1920, and in 14 I have been unable to trace the patients after they had left the hospital or nursing home. These last 14 were all quite well when last seen, and I have no reason to suppose that they are not all quite well at the present time.

Table X.—SOURCES OF INFORMATION OF LATE RESULTS.

Traced in 1920 (May to December):—		
By personal observation	109	
„ letters from doctors	191	
„ „ „ patients	130	
„ „ „ relations, friends, etc.	26	
	—	456
Traced before 1920:—		
By personal observation	13	
„ letter from doctors	11	
„ „ „ patients	2	
„ „ „ relations, etc.	4	
	—	30
Untraced since leaving hospital or nursing home (all primary union) ..		14
Total		500

The most important table of this paper is the following, which gives a full summary of the information obtained as above described.

Table XI.—LATE RESULTS.

SIMPLE GOITRE (Operations 408: Patients 406).

Quite well		342
Quite well after subsequent operation on thyroid elsewhere		3
Not well „ „ „ „ „ „		1
Well as regards goitre, but since undergone other major operations (amputation of breast, hysterectomy, etc.)		3
Well as regards goitre, but with other symptoms, mostly minor:—		
Become very stout	2	
Stomach troubles	4	
Uterine „	2	
Nervous „	2	
Cardiac „	5	
	—	15
Well until occurrence of other fatal illness or injury unconnected with thyroid operation. (*See Table XII*, p. 451)	9	
Spasmodic asthma until occurrence of other fatal illness or injury unconnected with thyroid operation. (*See Table XII*) ..	1	
Condition unknown until occurrence of other fatal illness or injury unconnected with thyroid operation. (*See Table XII*) ..	2	
	—	12
Well, but with enlargement of opposite lobe: causing trouble ..	5	
„ „ „ „ „ „ not causing trouble	4†	
	—	9
Well, but with local troubles:—		
Paralysis of vocal cord subsequent to operation ..	3‡	
"Dragging sensation in throat"	2	
	—	5
Died of operation		2
Untraced since leaving home or hospital (well and wounds healed then) ..		14
		— 406

* A large number of those from whom I received information by letter were also subsequently seen and examined by myself.

EXOPHTHALMIC GOITRE (Operations 79 : Patients 78).

Practically well	53§	
Much improved	18§	
Improved	1	
No improvement	2	
Worse	1	
Died of operation	3	
Untraced	0	
	—	78

MALIGNANT AND PAPILLIFEROUS GOITRE (Operations 13 : Patients 12).

Living and quite well after years : $7\frac{1}{2}$, $2\frac{1}{4}$, 2, $1\frac{1}{3}$, 2	5	
Fairly well with recurrence „ „ $1\frac{1}{2}$	1	
Died subsequently of recurrence „ „ 1, $\frac{3}{8}$, $\frac{2}{3}$, $\frac{1}{4}$	4	
Died of operation	2	
	—	12
		496
Add those operated upon twice		4
Total		500

† Probably many more not recorded.
‡ Possibly some others not recorded.
§ 2 died subsequently of other causes.

This table explains itself and requires but little additional comment under the three main heads.

Simple Goitre.—It will be seen that, with but few exceptions, all the patients are well. Most of them have not only been relieved completely of all the trouble from which they suffered before the operation, but enjoy much better health than formerly. I have a large bundle of letters from patients expressing the utmost gratitude for the benefit they have derived from the operation. The following is a representative selection :—

No. 771. A woman, seven years after the removal of a cystic adenoma at the age of 23, on account of dyspnœa, writes : " I have never felt so well as I have done in the last seven years ".

No. 777. Another woman, seven years after operation at the age of 46, for dyspnœa and palpitation, writes : " My general health has never been better in every way than since I had the operation for goitre. I am quite well at the present time ".

No. 827. A district nurse, seven years after removal, at the age of 49, of 8 oz. of goitre, for dyspnœa and palpitation, writes : " I have never had a day's illness since I left the hospital. I have been working hard ever since. I never get palpitation, and I can walk for miles without the least exhaustion ".

No. 838. A gentleman, seven years after removal for dyspnœa, at the age of 67, of a 5-oz., much calcified, adenoparenchymatous goitre, writes : " Before the operation, life was really not worth living ; now it is a pleasure to live ".

No. 911. A lady, six years after bilateral resection-enucleation, at the age of 42, of an adenoparenchymatous goitre, for dyspnœa, writes : " I have not had the slightest return of the symptoms which distressed me so much before. I am infinitely better in health, and I think I am more regularly and consistently energetic than I used to be ".

No. 1074. A girl, three years after a bilateral resection-extirpation, at the age of 14, of 11 oz. of parenchymatous goitre, for dyspnœa, writes : " I am in the best of health and never feel anything of my throat ".

No. 1101. A lady, two and a half years after bilateral removal of an adenoparenchymatous goitre, for dyspnœa at the age of 27, writes : " I am quite well and in splendid health ".

No. 1114. A gentleman, two years after bilateral resection-extirpation, at the age of 19, of $23\frac{1}{2}$ oz. of parenchymatous goitre, for dyspnœa and great deformity, writes : " From the time you operated on me, I have been a new man. I have been able to take part in the most strenuous of outdoor games, a thing I was practically unable to do for a number of years previously. The effect of the operation has been wonderful, and has resulted in a complete cure, for on no occasion have I ever felt any ill effects whatsoever. Sometimes I almost forget that once I had a goitre ".

No. 1133. A lady, two years after removal for dyspnœa, at the age of 34, of an adenoparenchymatous goitre weighing $3\frac{1}{2}$ oz., writes : " Quite well and a very different woman from what I was before the operation ".

No. 1144. A woman, two years after bilateral removal, at the age of 57, for tachycardia and slight dyspnœa, of an old adenoparenchymatous goitre of 5½ oz., writes: "I am delighted to inform you what a great difference in my life the operation has made; the exhausted feeling is gone. I am gaining in weight, although leading a very busy, active life".

FIG. 304.—No. 760. Recent scar, showing the usual low collar incision, in a position where the scar can easily be hidden by a necklace. F., age 47, after removal of a solid adenoma of the right lobe weighing 6 oz. (Scar shown is too thick, but has been chosen because it shows up better in the photograph.)

FIG. 305.—No. 1090. Similar scar 2½ years after bilateral extirpation of adenoparenchymatous goitre weighing 4¾ oz. F., age 29.

FIG. 306.—No. 1020. A similar scar 4½ years after extirpation of left lobe and isthmus. F., age 36.

No. 1168. A gentleman, one and a half years after removal, at the age of 54, of an old cystic adenoma weighing 14 oz., for bulk and deformity, writes: "I am quite well; the operation has been a complete success and I have been quite a different man ever since".

No. 1169. A woman, one and a half years after a bilateral removal for dyspnœa, at the age of 40, of a goitre weighing 5½ oz., writes: "I am now feeling better than I have ever felt before. I did think at one time that I could not live long. As I could not breathe life was not worth living, but now I can breathe freely".

No. 1195. A lady, fifteen months after removal, at the age of 38, for discomfort and slight dyspnœa, of a cystic adenoma weighing 4 oz., writes: "I am wonderfully better than I used to be before my operation. I can do so many things that were quite out of the question before. For instance, I frequently bicycle fourteen miles a day, which would have been an impossible task for me before my operation last year. I can never feel thankful enough to be rid of that terrible goitre after suffering with it for so very many years.

The scar on my neck has almost disappeared, and it is quite unnecessary to wear any beads or anything to hide it now".

No. 1249. A woman clerk, one year after removal of a small adenoma, at the age of 45, for discomfort, depression, and slight dyspnœa, writes: "My throat is considerably relieved in every way. My general health and vitality are now better than they have been for many years, and I have lost that ever-accompanying depression entirely".

Exophthalmic Goitre.—I have found that it is very difficult to make a satisfactory classification of the results of operations for exophthalmic goitre, but I think that that shown in the table is fairly accurate. Complete and absolute cure, with no trace whatever of the previous symptoms, is comparatively rare after operations for true exophthalmic goitre. Some palpitation on exertion, or after unusual excitement, and especially some degree of exophthalmos, often a considerable amount, remain in patients who consider themselves to be otherwise quite well. Nevertheless, a large number have been changed from invalids who previously were wretched and miserable to comparatively happy beings able to do a good day's work and enjoy life. Nearly all express themselves as being extremely grateful for the benefit they have derived from the operation. A few are no better, and some remain depressed and miserable. After a tolerably large experience of operations for this class of goitre, the following points have impressed themselves upon my mind:—

That the operation is much more dangerous than most operations for simple goitre with dyspnœa. Even when the greatest care is taken in the selection of the case that is considered suitable for operation, and in choice of operation, its extent, and the manner of its performance (all important points), disasters and failures will sometimes occur.

That many cases, when first brought to the surgeon with a view to the performance of an operation, are wholly unsuitable for any operation at that time.

That many acute cases, unsuitable for the larger operations of hemithyroidectomy, are nevertheless often capable of standing the less dangerous operation of ligation of one or both superior thyroid arteries, and often derive great benefit from this.*

That the condition of the heart, especially as regards the amount of myocardial degeneration, is a very important factor in deciding whether an operation should or should not be undertaken.

Finally, even when the operation has seemed to be most successful and the patient has appeared to be well for a long time, relapse may occur.

As, however, the medical and surgical treatment of exophthalmic goitre is to be the subject of a further communication, it is not necessary to say anything more now on this branch of thyroid surgery.

Malignant and Papilliferous.—The five patients who are still alive and well are the following:—

No. 755. A lady, age 33, who had already undergone an operation at the hands of another surgeon for the removal of an outlying gland, underwent, seven and a half years ago, removal of the right lobe and two separate infiltrated glands in the neck for endothelioma, evidently

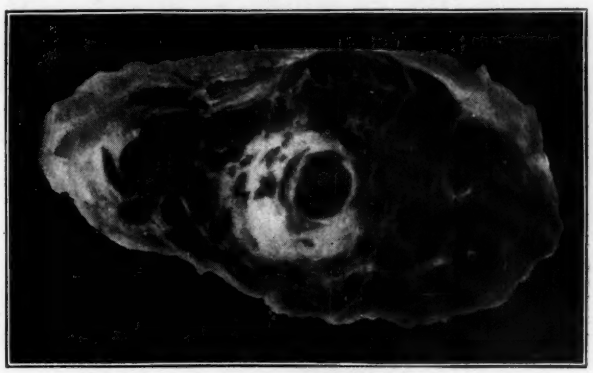

FIG. 307.—No. 1178. Spheroidal-celled carcinoma, removed with glands from F., age 44. Secondary growth appeared on a rib 19 months after operation. *R. Free Hosp. Mus.—Ea. Rb.* 425.)

* With the subject of ligation of thyroid arteries, this paper, which deals only with cases of *removal* of some portion of the thyroid, is not concerned. Of removal of the thymus for exophthalmic goitre I have no personal experience.

a tumour of low degree of malignancy; she remains quite well and free from recurrence. The primary tumour was about as large as a small walnut.

Nos. 1129, 1146. Two male patients, age 26 and 46, with slow-growing adenocarcinomata, underwent extensive operations, the first involving also the removal of many glands. Both are now, two years later, in excellent health, but the first still has some infected glands which do not trouble him and for which he at present refuses further operation.

No. 1109. A lady, age 47, with a large papilliferous carcinoma of eight years' duration, very similar to the case described on p. 442, is still in excellent health two and a quarter years afterwards.

No. 1140. *Fig.* 286. A woman, age 65, with a small spheroidal-celled carcinoma involving one lobe only, was reported to be quite well when last heard of fifteen months after operation.*

XII. COMPLICATIONS.

Recurrent Laryngeal Nerve Paralysis.—The only complication of the operation, beside those already described, is paralysis of a vocal cord, which is known to have occurred three times. This is an accident which should not occur, but is sometimes unavoidable, especially in cases of large and deep-seated tumours. One case is that of the large intrathoracic tumour described on p. 436.

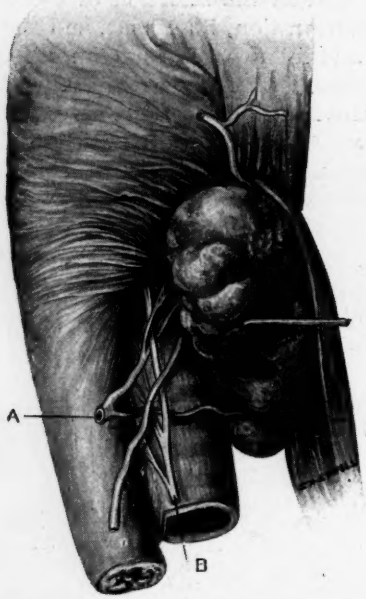

FIG. 308.—Dissection showing recurrent laryngeal nerve (B) and inferior thyroid artery (A). The thyroid gland has been drawn forwards.
(Dissected by Prof. F. G. Parsons.)

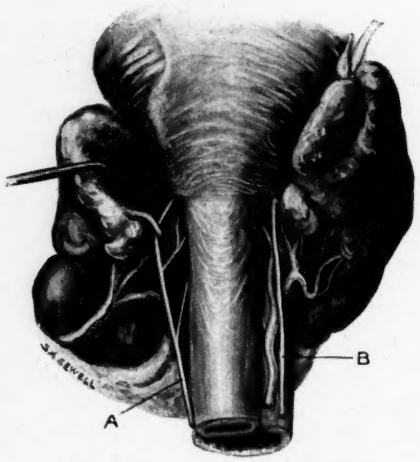

FIG. 309.—Similar dissection seen from behind. On right side the close proximity of the nerve (B) to gland is shown. The left side shows how pulling gland forwards may displace the nerve (A) and render it more liable to injury during an operation.
(Dissected by Prof. F. G. Parsons.)

The tumour may displace the nerve from its normal situation, and the best way of avoiding it is to be thoroughly acquainted with the situation in which it is likely to be found, and the alteration which occurs in its position when the trachea is displaced, or when during the operation the thyroid lobe is drawn forwards, as the nerve may be drawn forwards with it. The point at which the nerve is most likely to be cut or clamped is not far below the lower border of the pharynx. It will be seen from the accompanying

* As these sheets are passing through the press (Feb., 1921), further news comes from her doctor that this patient has since died, " presumably of recurrence in the thorax ", twenty-two months after operation.

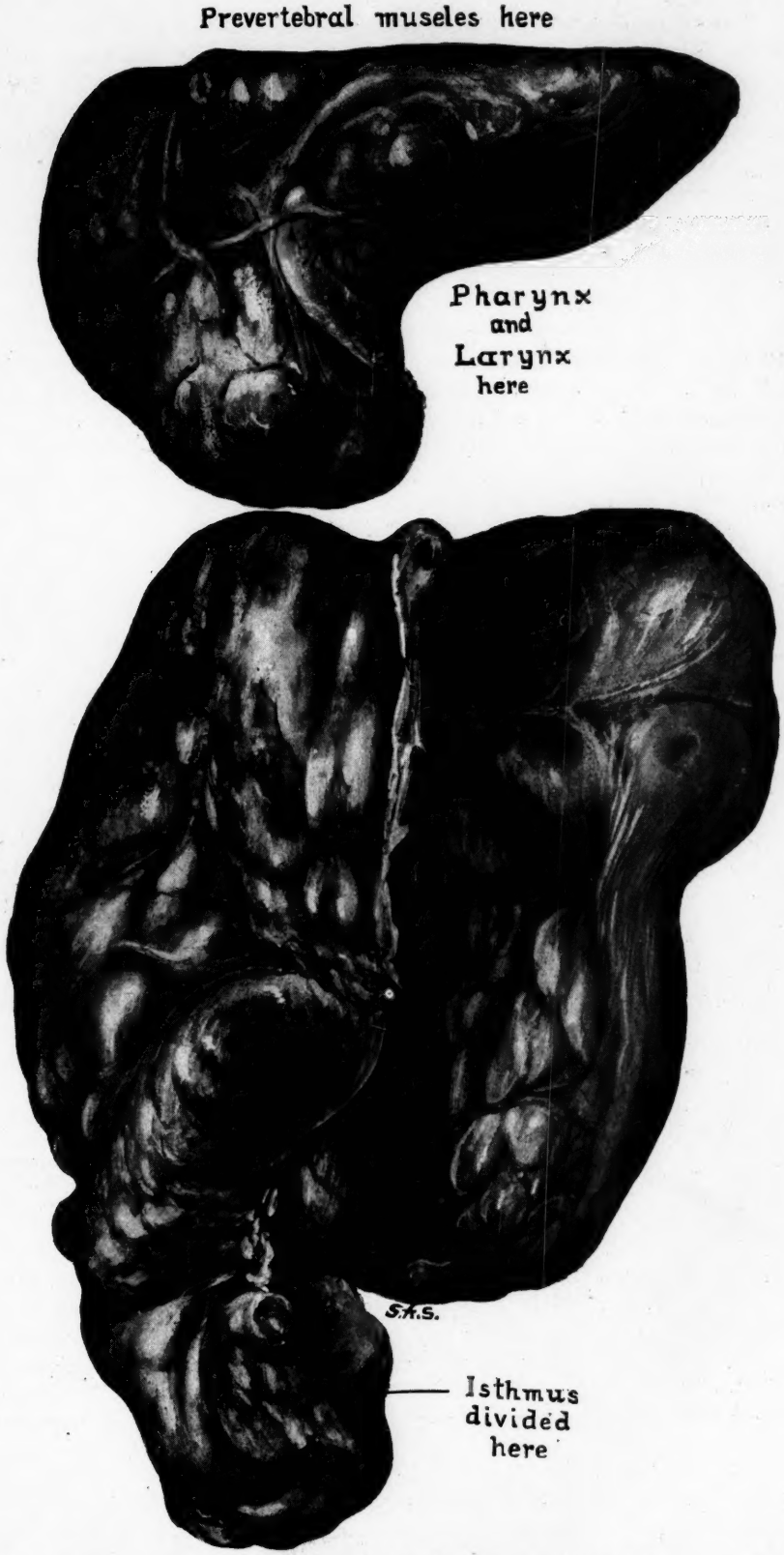

FIG. 310.—No. 1304. A solid, largely retropharyngeal right-sided goitre removed from F., age 44. Weight 11 oz. (*Natural size.*)

drawings of dissections, which have kindly been made for me by Professor F. G. Parsons, and are now in the anatomical department of St. Thomas's Hospital, that the nerve does not lie actually in the groove between the œsophagus and trachea, but a little in front of this. For the acquisition of that correct anatomical knowledge which is so essential for the proper performance of the more difficult thyroid operations, I would strongly urge the study of the dissected preparations of which such large numbers exist in most of our pathological museums, especially the older ones.

The relation of the posterior part of the gland to the pharynx is one of especial importance, since it so frequently happens that this portion of the goitre, especially in parenchymatous cases, extends round behind the pharynx as far as the middle line, or even beyond it. This backward and inward extension may be a source of considerable embarrassment to an inexperienced operator. (See *Figs.* 287 and 310).

Fig. 310 (1304) illustrates an unusual degree of this postpharyngeal extension, and also the fact that a vocal cord paralyzed before operation by the pressure of a goitre will occasionally, although not often, recover after operation. This lady, age 44, was sent to me by Sir StClair Thomson, mainly because of the paralysis of the right cord. She made a rapid recovery, and he tells me that the movements of the cord have now, five months later, been completely restored.

Another patient (No. 785), a professional singer, age 52, from whom in 1913 I removed a solid adenoma weighing 6 oz., partly for dyspnœa but mainly because she was losing her voice, has completely regained it.

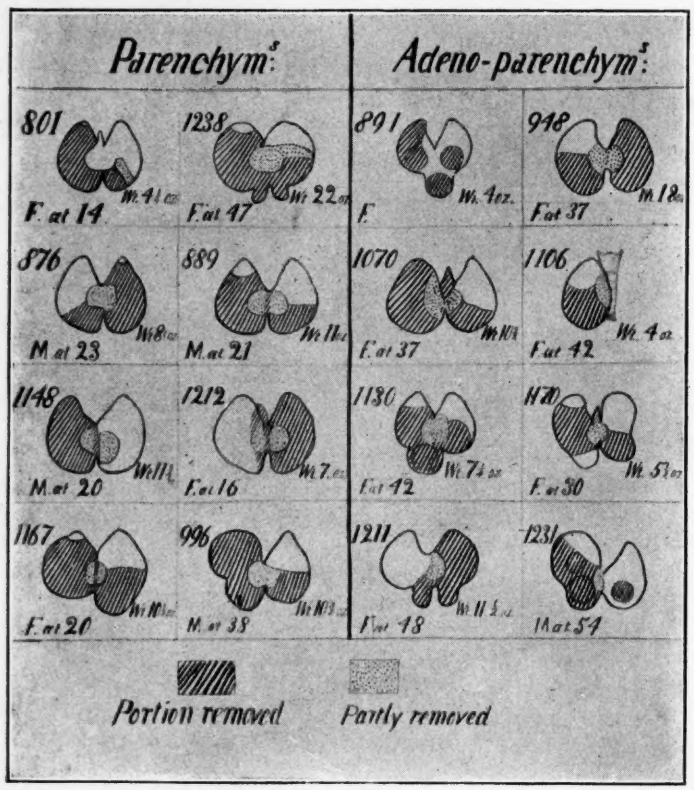

FIG. 311.—Representative diagrams of operations for parenchymatous and adenoparenchymatous goitre, showing amount of gland removed in each case. From rough sketches made by the author immediately after operation.

Thyroid Insufficiency.—With regard to the quantity of gland that should be removed in an operation for goitre, I would say that as little should be removed as will suffice to remove the symptoms for which the operation is undertaken, that the whole gland should never be removed, and that the hilus should be interfered with as little as possible; much must depend on the nature of the goitre and the extent of its degeneration. Myxœdema will then not occur. There has been no marked case of myxœdema after any of my operations, although in a few cases, chiefly of very extensive bilateral removals, the patients have suffered for a time from transient symptoms of thyroid insufficiency, and have been all the better for the administration of a little thyroid occasionally. It should not be forgotten that some goitre patients with much degenerated thyroid gland suffer already to some extent from thyroidal atrophy. With such patients, if operated upon at all, much care must be taken to remove as little as possible of secreting gland tissue.

Tetany.—Although I have up to the present time performed operations for the removal of goitre 1338 times, I have never seen tetany after any of my operations, nor have I ever heard of any case of mine in which it has occurred subsequently. The exact cause of tetany after thyroid operations is still, in my opinion, obscure. The ordinary explanation that it is due to injury of the parathyroid glands seems to me to be not by any means satisfactory.

A mountain of literature has grown up round the subject of the parathyroids, and I must confess myself still an impenitent sceptic as to the supposed separate function of the parathyroids. I never take any special care to avoid them, although I usually do leave a piece of gland at the hilus for many reasons. It may be that, like the famous character in Molière's play, who had been speaking prose all his life without knowing it, I have all along been taking special precautions to preserve the parathyroids without knowing it. The practical point seems to me to be that, provided you leave a piece of gland at the hilus, you need never trouble about the parathyroids at all.

Even if I wished to remove all the parathyroids, I could not be sure of doing so without performing a complete removal of the whole gland, or damaging it so much at the hilus on both sides that it would be practically useless. Besides, even if all four parathyroids could be removed, there would still remain the so-called parathyroid tissue that exists within the gland itself.

Undoubtedly tetany has often occurred after complete thyroidectomy, but this is an operation that I have never in my life performed. I have never seen any case in which I have wished to do this operation, and I doubt whether the necessity for doing it ever arises. It certainly never does in any form of innocent goitre.

XIII. SUBSEQUENT DEATHS FROM CAUSES UNCONNECTED WITH OPERATION.

Table XII.

No.	Sex	Age	Cause of Death	After	Intermediate Condition
SIMPLE GOITRE:—					
814	M.	70	"Bronchitis and heart" ..	3 years	Not known
951	F.	57	"Heart dropsy"	4 ,,	"Wonderfully well"
881	F.	22	"Bright's disease	2½ ,,	Well (married)
840	M.	37	"Some acute illness" ..	6 ,,	Well
864	F.	52	Diabetic coma	4 ,,	Well but diabetic
887	F.	51	Carcinoma, breast	3½ ,,	Not known
930	F.	63	,, œsophagus ..	3/52 ,,	Not known
927	F.	40	Cause unknown	3–4 ,,	Well
889	M.	21	Killed in battle	3 ,,	,,
820	F.	43	Run over	7½ ,,	,,
811	F.	32	Childbirth	3/52 ,,	,,
1156	M.	26	Spasmodic asthma	1½ ,,	Asthmatic
EXOPHTHALMIC:—					
847	F.	40	Violence	7/12 ,,	Ill of exophthalmic goitre
851	F.	20	Acute influenza	6 ,,	Well
867	F.	25	Acute rheumatic fever ..	4 ,,	,,
1225	F.	37	Heart disease	7/12 ,,	Much improved
MALIGNANT:—					
754	F.	40	Recurrence of carcinoma ..	1 ,,	Gradually getting worse
950	F.	50	,, ,, ,, ..	3/52 ,,	,, ,,
1040	F.	59	,, ,, sarcoma ..	3/52 ,,	,, ,,
1198	F.	54	,, ,, ,, ..	1/4 ,,	,, ,,

If the after-history of any series of 500 persons, whatever be the matter with them, is traced over a long period of years, it will be found of course that some have died. *Table XII* shows, as far as any mere table can show, what I believe to be correct, namely, that none of the deaths in it are in any way attributable to the operation for goitre.

INTESTINAL STASIS FOLLOWED BY CYSTIC DILATATION OF THE CÆCUM, WITHOUT INTESTINAL OBSTRUCTION.

By W. G. SPENCER, London.

WITH PATHOLOGICAL REMARKS ON CYSTS AT THE ILEOCÆCAL VALVE AND ON THE CÆCUM EXCISED, WITH A CONTRIBUTION TO THE PATHOLOGY OF INTESTINAL STASIS.

By ARTHUR KEITH,
Conservator of the Museum, Royal College of Surgeons of England.

I. DILATATION OF THE CÆCUM INTO A LARGE CYST WITHOUT INTESTINAL OBSTRUCTION.

Miss R., age 44, was for a number of years on the nursing staff of the Westminster Hospital; latterly she had been engaged in district nursing, and had continued on duty until a few days before the operation. She had always been spare and a small eater; she had been troubled by constipation, and had had at times attacks of colicky pain. On one occasion she was medically examined, and as there was then tenderness in the ileo-cæcal region, the existence of appendicitis was suggested; but the tenderness passed off without any concomitant symptoms. The abdomen had become slowly distended; this had not been noticed for longer, certainly, than six months, and serious attention had only been directed to it during the previous few weeks.

It was generally concluded, on her admission, that she had an ovarian cyst. I examined her fully both before and after the bowels had been moved three times following the administration of an aperient and an enema; moreover, there was no alteration in the abdominal tension after she was anæsthetized.

The abdomen was distended by an elastic swelling which bulged forwards; it was dull to percussion, and a well-marked wave was transmitted across it. The line of dullness reached midway between the umbilicus and xiphoid cartilage, the upper margin varying with respiration. The flanks were flat and tympanitic; a finger in the rectum did not reach the cyst.

An incision in the middle line of the hypogastrium, commencing a little below the umbilicus, exposed the wall of a cyst, bluish in colour; the index finger passed round between the cyst-wall and the parietal peritoneum met with no adhesions. A large trocar was then plunged into the cyst, whilst the wall of the cyst was seized on each side of the trocar with toothed clamp forceps. It is important to note here that the perforation of the cyst-wall was made in the middle line of the abdomen, half-way between the umbilicus and the pubes. All the fluid escaped at once through the trocar into a bucket; none leaked beside the trocar; within a minute a completely emptied thin-walled cyst was sucked tightly around the trocar owing to the siphonage.

The empty cyst being partly drawn outwards, contracted coils of intestine were noted on the inner side, and the wall of the cyst presented muscular fibres. Search was now made on the outer side and to the right along the line of junction between the parietal and visceral peritoneum. The appendix was first shelled out, some six inches in length, the tip extending over the brim of the pelvis, where it was firmly fixed by a dense band. Tracing the appendix in the reverse direction, it was found continuous without any kink, with an infundibulum which opened into the cæcum, close to where

the puncture had been made. It was only then that the nature of the cyst was disclosed. Above what had formed the cyst-wall was the colon, convoluted concertina-like, obscured by fibrous adhesion. To the inner side and behind, the termination of the ileum was continuous with the colon.

The further progress of the operation reduced the cystic dilatation of the cæcum and the convoluted colon into a featureless tube (*Fig.* 314). Beforehand the ileocæcal valve was continuous with the ascending colon above the limits of the cystic dilatation. The communication did not appear to be like that form of intussusception in which the ileocæcal valve heads the intussusceptum. One may compare the state before operation to that existing in the stomach of a ruminant, in which, whilst the rumen is distended, fluid may pass from the cardiac to the pyloric end along a tube formed by muscular contraction which shuts off communication with the rumen for the time being.

Fig. 312 suggests an explanation of why there was no intestinal obstruction.

The cæcum which had been dilated, and the convoluted colon, were now shelled out, whilst mesocolic blood-vessels were secured, after which the end of the ileum together with the ileocæcal valve was implanted into the transverse colon a little on the proximal side of the splenic flexure.

After this the interior of the abdomen was inspected and palpated. The viscera were seen to be veiled, as if by a single layer of gauze; only the anterior surface of the

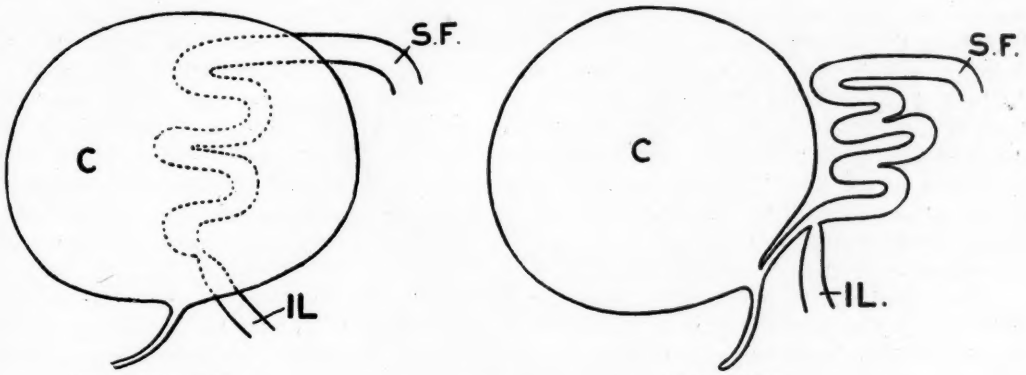

FIG. 312.

C, Cæcum dilated into a cyst: IL, Ileum continuous through the ileocæcal valve with the convoluted colon. S.F., Splenic flexure of colon.

stomach and the liver showed glistening peritoneum. The viscera were palpated in turn and found normal; in particular all the small intestines were contracted; there were no U-shaped loops. The gauze-like veil of fibrous tissue over the viscera was doubtless the result of mechanical friction by the cyst wall. The bowels were moved on the following day. Later, a series of *x*-ray photographs after a bismuth meal afforded evidence of free intestinal movement through the ileocolic anastomosis.

The patient was examined six months after the operation. She had gained 1½ stone in weight; had improved in colour, having been free from constipation, indigestion, and flatulence; and was about to resume work. Apart from the abdominal distention, the patient had been relieved from the effects of constipation.

The Fluid Contained in the Cyst.—The fluid was all collected, and measured 7½ pints (4·25 litres). It was a uniformly thin dark-brown fluid, brightly glistening from cholesterin, without any solid particles such as fibrin or viscid material. It was entirely without fæcal odour, yet it was noted at the time of dividing the end of the ileum that its contents were yellowish and had the characteristic odour; the end of the divided colon contained brown fæces.

The fluid was immediately examined by Dr. Braxton Hicks; he noted red blood-corpuscles in all stages of decomposition; there was abundance of cholesterin crystals,

but no micro-organisms were seen. As the fluid had all been collected in an open bucket and soon began to decompose with a foul odour, no further examination was made.

It is clear from the clinical history, the tension of the cyst unaltered by the administration of the aperient, and the character of the fluid, that it had been slowly formed by the wall of the cæcum shut off from the colon. Questioned after the operation, the patient could not remember any interruption in the slow enlargement of the abdomen, nor any escape of fluid with her motions.

Supposing—as a result of constipation and a degree of intestinal stasis producing the changes in the wall of the gut described below by Dr. Keith, and the fibrous covering from which the bowel was shelled out—that there was set up an exaggeration of the transverse haustra of the colon, the concertina-like convoluted condition in which the colon was found may be explained. Also this would explain how a constriction at the junction of the cæcum and colon, involving only the peritoneal surface and outer coat, disappeared as the bowel was being removed.

II. PATHOLOGICAL REMARKS.

When first given an account of this case I confidently predicted that the cyst met with would prove to be one situated in the ileocæcal angle of the mesentery, and to be of embryonic origin. A number of these ileocæcal cysts have been encountered by surgeons, but so far no good figure of one has been published. It may therefore be useful to reproduce the accompanying drawing (*Fig.* 313), made from a specimen in the R.C.S. Museum, which was obtained from the body of a full-time, stillborn child. The wall of the cyst shows a lining of mucous epithelium covered by a muscular coat, which has over it a peritoneal covering derived from the anterior layer of the mesentery passing to the ileocæcal junction. The cyst, of the size of a pigeon's egg, has no communication with the lumen of the bowel. Nor have such cysts any morphological significance; they arise in the latter part of the second month of development as extensions from the epithelial lining of the bowel. Why the ileocæcal junction should be a common site for such embryonic extensions is not known.

The specimen here described, however, proved to have nothing to do with an ileocæcal cyst. The point at which the trocar entered is seen (*Fig.* 314) to be situated in the anterior wall of the cæcum, which in the collapsed hardened viscus is situated 1 in. (2·5 cm.) below and in front of the ileocæcal junction. There thus remains no doubt that the cyst was formed by a greatly distended cæcum.

The cæcum in its collapsed state measures $2\frac{1}{2}$ in. (7 cm.) in length and only $1\frac{1}{4}$ in. (3 cm.) in width. The peritoneal coat had been stripped away with part of the external muscular coat. To the naked eye the muscle of the cæcum showed no departure from the normal save in the broken appearance of its fasciculi. The viscus tapered to a conical apex from which came off a long appendix measuring $5\frac{3}{5}$ in. (13·5 cm.) in length and $\frac{1}{3}$ in. (8·5 mm.) in diameter. From it, too, the peritoneal coat has been stripped away, and also the greater part of the longitudinal coat, thus exposing the circular coat, which is firmly contracted. Sections across the appendix at two points show its lumen to be open, its epithelial lining intact; five to six follicles are seen in each transverse section, some of these breaking down in the centre. The only marked departure from the normal state occurs in the submucous coat, which becomes densely fibrous where it approaches the inner muscular coat, as if it had been the site of a chronic inflammatory process. The circular muscular coat is healthy. In its present highly contracted state the tract of colon removed measures over 21 in. (54 cm.). The first 4 in. (10 cm.) I regard as representing the ascending colon, the remainder the proximal part of the transverse colon. Along the whole length of this part, the musculature is most irregular in its arrangement and development.

Allowing for the shortened condition into which the tæniæ have been thrown by being preserved in formalin solution, there still remains evidence that there must have been a good deal of hypertrophy in the longitudinal coat, particularly in the tæniæ.

Apparently the ascending colon and the proximal part of the transverse loop were matted together in a confused mass, and in the course of separating the various coils the peritoneal coat was torn away from certain areas and the muscular coat and tæniæ were ruptured in places. At no point is there any localized stricture or obstruction; throughout the colon its breadth varies from 3 to 4 cm. It is the irregular spastic condition of its musculature which seizes one's attention.

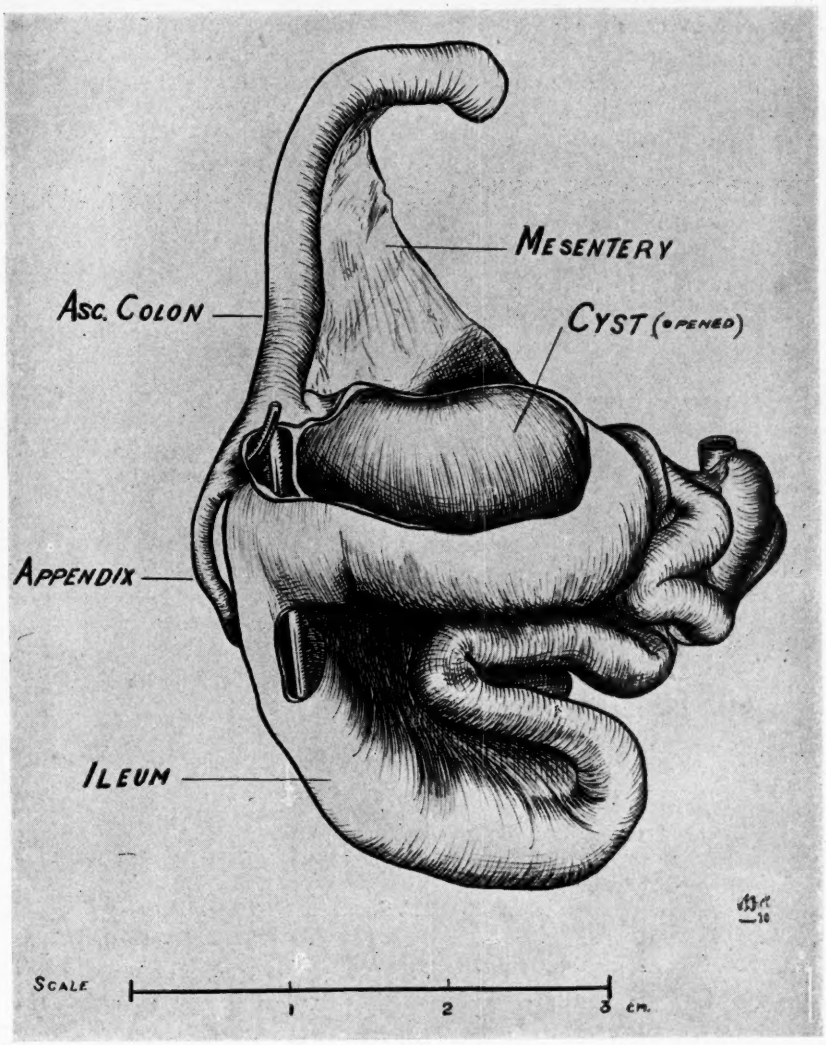

FIG. 313.—Drawing of a congenital ileocæcal cyst removed from the body of a full-time, stillborn child.

Microscopic examinations were made of the wall of the cæcum and colon at several points by Mr. J. Howard Mummery and the writer, various staining methods being employed. Examination of the muscular and mucous coats of the cæcum, which one would have expected to show marks of the enormous distention to which they had been subjected, reveals only minor departures from normal. As may be seen from *Fig.* 315, where a section of the cæcum from this case is compared with a section made from a healthy cæcum, the muscular coats are normal in thickness and arrangement. The outer coat shows some areas of degeneration, but such are not uncommon in cæca which

are counted healthy. The fasciculi of the inner coat are, for the greater part, separated into bundles which, on section, are sickle-shaped and placed widely apart, the separation being the result of the over-distention to which the cæcum has been subjected. The corresponding coats of the colon are thick, dense, and strongly contracted. The preservation of the bowel was not favourable to a minute examination of Auerbach's plexus. In the cæcum, and particularly in the appendix, of healthy normal individuals, this system is more slightly developed than in the colon. In the present instance such nerve-cells as could be detected in the cæcum were irregular and apparently atrophic. In the colon they were normal in number and in form. I am of opinion that a complete and

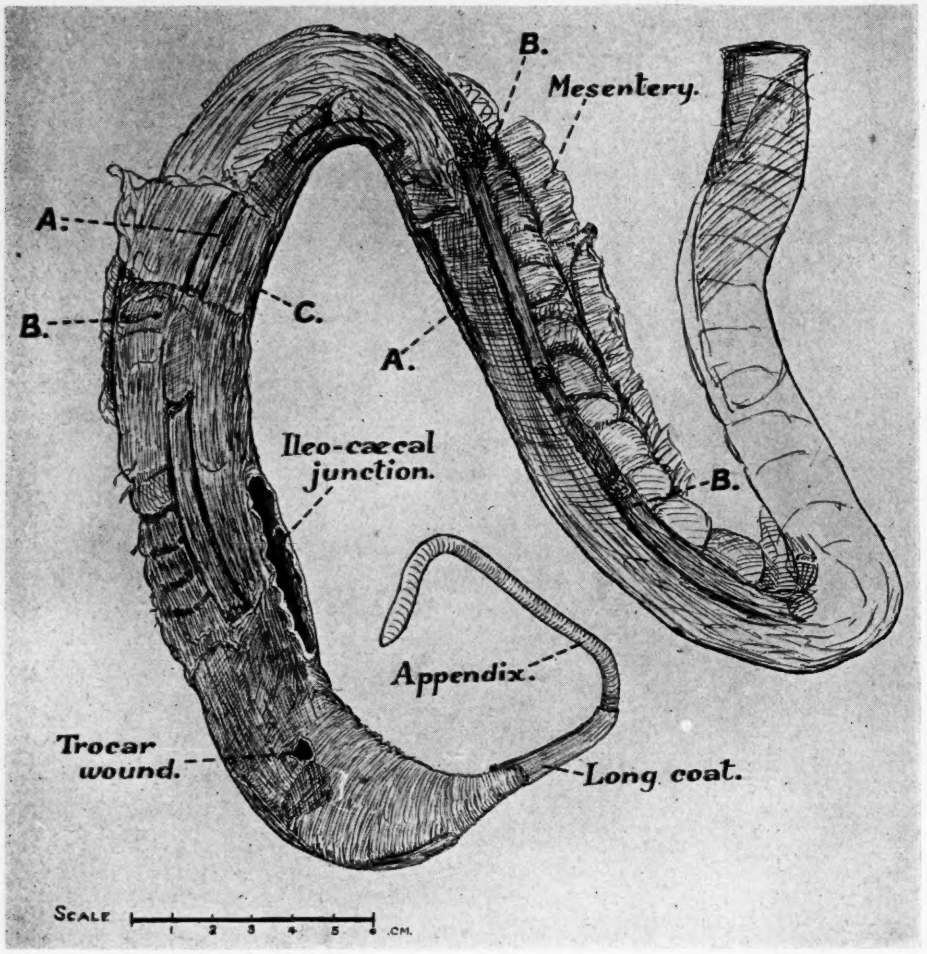

Fig. 314.—Drawing of the part of the bowel removed. The scale of reduction is indicated.
A, Anterior or free tænia; B, Omental tænia; C, Mesenteric tænia.

exact examination of the peripheral-nerve system of the cæcum in such cases as this will show degeneration in Auerbach's plexus; but the evidence so far at my disposal is little better than presumptive. The essential pathological state of the bowel excised lies in its mucous membrane.

Certain cells lying between the lower or blind ends of the tubular glands of the mucous membrane are overladen with a brown pigmented substance which Mr. Shattock, Pathological Curator R.C.S. Museum, has observed in cases where the lining membrane of the appendix was blackened by pigment. In this case, the mucous membrane, both

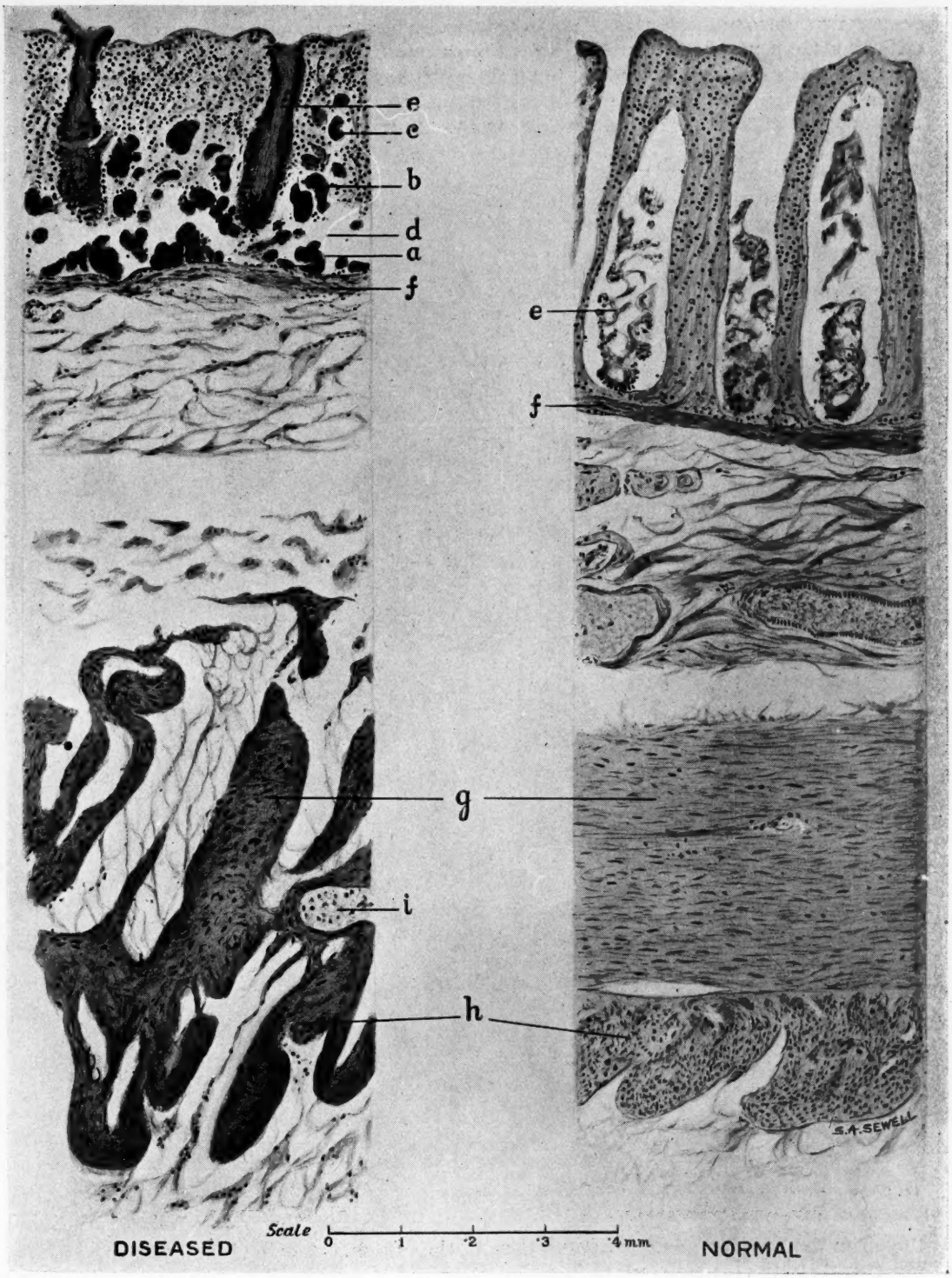

FIG. 315.—Section of the cæcum from this case compared with section of a normal cæcum. *a*, *b*, *c*, Cells laden with brown pigmented substance in various stages of transformation; *d*, Dilated lymph spaces or vessels; *e*, Lieberkühn's gland; *f*, Muscularis mucosæ; *g*, Inner muscular coat; *h*, Outer muscular coat; *i*, Auerbach's plexus.

of the cæcum and colon, is of a dark-brown colour, due to the pigment-laden cells in the deeper stratum of its substance. In recent years I have encountered collections of these cells in a large number of bowels excised on account of 'stasis'; they are said to occur in the intestines of healthy people, but I do not believe this to be true. However, I have never seen such a dense and continuous stratum of cells, overladen with brown pigment substance, as in this case; its abundance in the cæcum is shown in *Figs.* 315 and 316; in

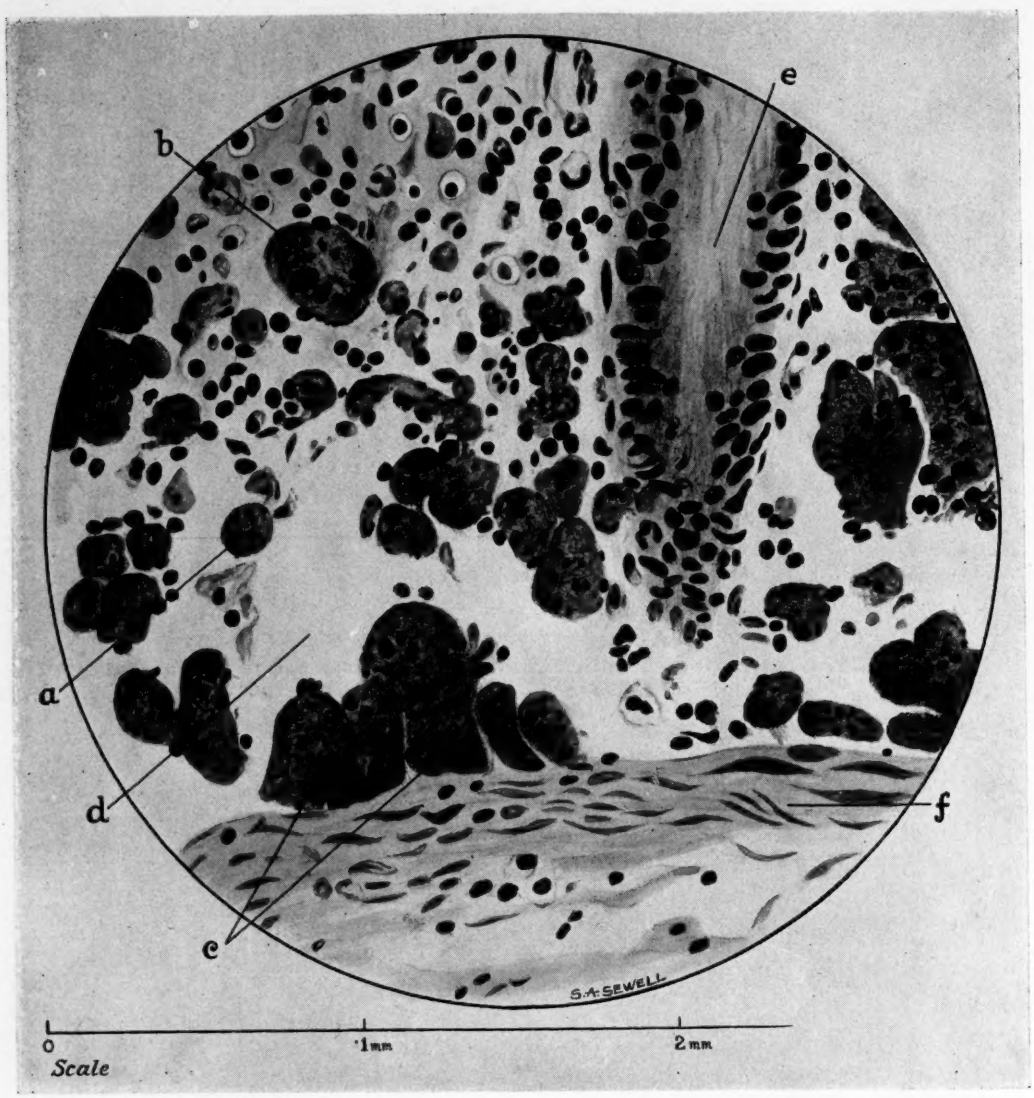

FIG. 316.—Pigment-laden cells, with the surrounding dilated lymph-spaces or vessels, in the cæcum of the case. *a*, Cells laden with brown pigmented substance; *b*, *c*, Groups of such cells in stages of being absorbed; *d*, Lymph space, dilated; *e*, Lieberkühn's gland; *f*, Muscularis mucosæ.

the colon the amount was much more than in the cæcum. A careful study has convinced me that these overladen cells, often distended until they have a diameter of 15 μ, or aggregated to form irregular masses of 40 to 50 μ in diameter, are endothelial in origin; they occur as normal structural constituents of blood-capillaries or of lymph-capillaries. Those lying under the surface of the epithelium of the mucous membrane or between the

more superficial segments of the tubular glands, although pigment can be observed in them, never become overladen and engorged as do the deeper cells placed between the fundus of adjacent glands and just above the muscularis mucosæ. Certain appearances lead one to believe that these cells migrate towards the deeper stratum as they become engorged, but of this I am by no means convinced. Always there are greatly dilated lymph-vessels or spaces around the clumped pigmented cells lying on the upper surface of the muscularis mucosæ ; there seems to be a positive obstruction to the outflow of lymph. The lymphatic obstruction must react on and hinder the venous circulation. Around the clumped, pigmented masses are numerous mononuclear lymphocytes which apparently are concerned in digesting and removing the accumulated pigmented débris. I cannot resist the inference that the presence of these large cells, engorged with pigmented matter, are symptomatic of a grave disorder in the economy of the colon.

As to the nature of the brown substance, I refer the reader to recent papers by Salkowski[1] and by Brahm and Schmittmann.[2] They regard it as a waste product, derived from the metabolism of fat, and that the pigment is of the same nature as melanin. There is, in the opinion of the writers just cited, some close relationship between the adrenal function, the motor-nerve plexus of the bowel, and pigment formation. I feel confident that these brown cells are related to the motor disorders of the bowel, and when they occur are indications of the existence of constipation.

My interpretation of the case is that the cystic dilated condition of the cæcum was a sequel to a spastic state in the muscular coats of the proximal colon, as the result of a long-standing intestinal stasis of which the adhesions of the cæcum and appendix are evidence. In certain animals, such as rodents, the cæcum is marked off from the colon by a well-marked sphincter. I have seen many cases in formalin-hardened human bodies where the proximal colon was contracted as if it served as a sphincter. There must be a close functional co-ordination between the cæcum and proximal colon, just as between the stomach and small intestine. In the present instance this co-ordination appears to have broken down. The matting together of the cæcum and proximal colon shows that the patient had suffered for a considerable period from that clinical entity described as intestinal stasis. We are apparently dealing in this case with one of the terminal results of stasis ; but in this instance the obstruction in the colon cannot be attributed to any extrinsic cause such as bands or kinks. The condition is one affecting the motor mechanism.

In my opinion the method of preserving the ileocæcal sphincter and valve, and implanting them into the distal colon, has much to commend it from a functional point of view.

REFERENCES.

[1] Salkowski, *Virchow's Archives*, 1920, 227, 121.
[2] Brahm and Schmittmann, *Ibid.*, 137.

THE CLOSURE OF SEPTIC BONE CAVITIES FOLLOWING GUNSHOT WOUNDS BY MUSCLE-FLAPS.

By DUNCAN WOOD, Bristol.

The problem of healing up old discharging sinuses leading down to a cavity in a bone has, for a long time, engaged the attention of surgeons. Since the war, the necessity of solving the problem has become intensified. A large number of ex-soldiers suffer from this complication of their gunshot wound. It not only entails their being absent from their work whilst attending for dressing at local clinics, but the constant septic discharge may, in time, cause lardaceous disease. Af. Schultzen quotes a case where the sinus was discharging for nine years. At the time of operation the patient had albuminuria, which disappeared when his wound was healed ; in my *Case* 16 of the following series, the sinus was discharging for over three years ; albuminuria and anæmia were present, both of which cleared up after the operation.

This paper is based upon a series of twenty-four consecutive cases. The average time the wounds had been discharging was two years and eight months. Three cases had a persistent sinus for over four years. This is the type of chronic sinus leading down to a cavity in a bone, for which the operation to be described is advised. The difficulty of closing these cavities is shown by the numerous methods advocated.

1. Schede's aseptic blood-clot is the simplest of all, but a completely aseptic condition of the tissues must be procured, otherwise the blood-clot acts as pabulum for the bacteria present.

2. The insertion of substances such as solidifying paraffin, and Senn's decalcified bone-chips. These substances have no bactericidal power. When placed in cavities following gunshot, the wound tends to break down on the fourth to eighth day, and the contents become exposed, and slowly extrude.

3. Antiseptic plugs, such as Beck's bismuth paste, and Rutherford Morison's B.I.P.P., tend to counteract the septic conditions. But in large cavities a considerable quantity of the paste will be required, and may lead to poisoning by absorption.

4. Von Eiselsberg's osteoplastic flaps method, and Af. Schultzen's crushing in of the bony wall of the cavity, are unnecessarily severe. Massive necrosis of the bone has followed the latter method. Af. Schultzen, whilst recommending it for the upper end of the tibia, agrees that it is too destructive for single bones like the femur.

5. Broca advised the removal of so much bone that the soft parts would fall into the resulting depression of their own accord. Unless the cavity is very shallow, this method requires the removal of too much bone. Especially does this apply in the case of single bones, such as the femur and humerus. I was unfortunate enough, when attempting this technique, to fracture the femur. This finally led to the amputation of the limb. If a large quantity of bone is not removed, the overlying structures will be under tension if forced into the cavity. Again, the tissue will not fit the cavity as accurately as by a specially-cut flap of muscle.

6. Walton Martin advocates the use of fat-grafts to pack into bone cavities. He states that the fat splits into fatty acids and glycerin within the cavity, and that these do not readily support bacterial life. The fat-graft does not appear to have an active bactericidal action. He depends on three weeks' treatment by the Carrel-Dakin method, applied between the two stages of the operation, to procure asepsis. He only reports one case of a cavity due to gunshot wound, and this required three separate operations. It is simpler to produce relative asepsis in a cavity following tuberculosis or the later stage of osteomyelitis, than in those following gunshot wounds. Lefevre has tried this method

of fat-transplants, and quotes three failures due to the impossibility of rendering the cavity sterile.

7. The idea of filling up the large cavities with pedicled flaps of the soft tissues is not new. Af. Schultzen reported twenty cases operated on by him at Helsingfors in 1894. The cavities were the result of chronic, following on acute, osteomyelitis. His flaps consisted of deep fascia, muscle, and periosteum, with fragments of bone sometimes attached to the latter. The use of a flap of muscle to fill cavities following gunshot wounds has been advocated by Percy Sargent, Elmslie, and Lefevre. Its advantages are that for a successful result the bone cavity need not be absolutely sterile. Those who have been called upon to treat old-standing discharging gunshot wounds will appreciate the difficulty of making them aseptic. The pedicle muscle-flap is a living plug with its own blood, and often its

FIG. 317.—*Case* 17. Cavity in upper third of femur, filled with vastus externus by two-stage operation.

FIG. 318.—*Case* 13. Lateral view of lower third of femur before operation. Semimembranosus used to fill cavity.

own nerve-supply. It is consequently able to resist low degrees of infection. This is a great advantage over the other methods mentioned above. The use of muscle as a hæmostat is well known in brain surgery. Its similar action in bone cavities is of great importance. It prevents the accumulation of blood-clot, which would act as a pabulum for organisms in the wound.

If an abscess is present in the soft tissues, drainage of the abscess should be done as a preliminary to the main operation. In *Case* 7 the patient was admitted with this complication and a temperature of 103°. The abscess was drained and Carrel-Dakin

treatment carried out for twenty-five days. At the end of this time the bacterial count showed two cocci per field. A successful muscle-flap operation was then performed.

TECHNIQUE OF THE OPERATION.

The first step is to open up the cavity in the bone, and the second to place in that cavity a pedicled muscle-flap. These two steps are preferably done at one sitting, and this also applies if a sequestrum is found in the cavity. Sargent, Elmslie, and Lefevre also complete the two stages without an interval. Af. Schultzen advocated an interval of two to three weeks between the two steps. In the first he enlarges the bone cavity and

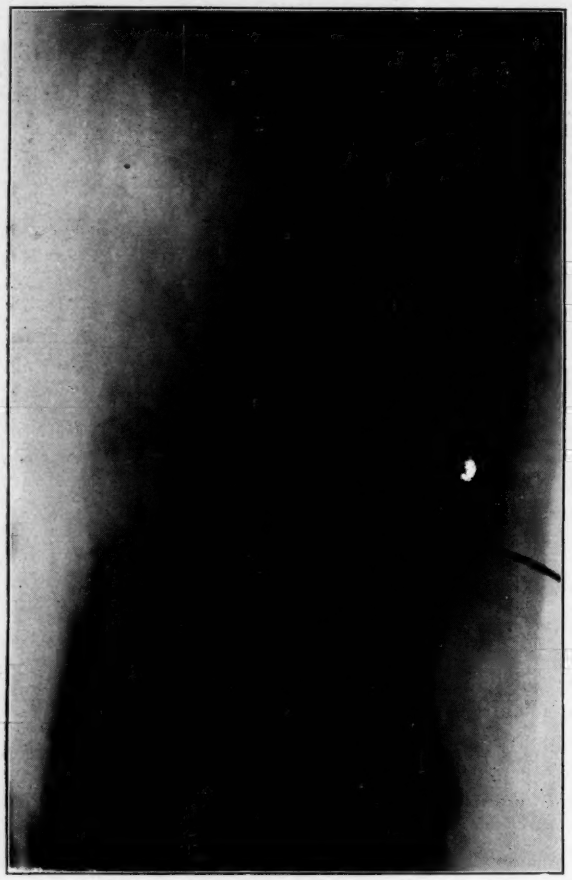

FIG. 319.—*Case* 18. Tunnel type of cavity. Probe points to cavity in lower third of femur. Quadriceps used as muscle-flap.

FIG. 320.—*Case* 15. Gutter type of cavity in femur. Filled by vastus externus.

leaves in a pack. In the second he cuts out and inserts a musculoperiosteal flap. This method was followed in *Case* 17 (*Fig.* 317), as there was a bag of pus found on opening up the cavity. In spite of this, the case is healing, though very slowly.

A tourniquet is not advisable on account of the oozing of blood which may follow its removal. Hæmorrhage into the cavity is not generally an embarrassing feature during the operation. A clear view can be obtained by a temporary tampon of gauze soaked in hydrogen peroxide. Sargent and Lefevre are both against using a tourniquet. Af. Schultzen, on the contrary, advocates its use, but in *Case* 5 of his series the hæmorrhage was so profuse after removing the tourniquet that a tampon had to be left in and the operation completed two days later.

The site of the incision depends upon the position of the sinus present. This may be adjacent to important vessels and nerves. *Case* 13 (*Fig.* 318), with a cavity in the femur, involved dissecting out the femoral artery from the scar tissue. In this type of case Af. Schultzen approaches the cavity through normal tissue on the other side of the limb. The disadvantage of this method is that the scar tissue surrounding the sinus is not touched, causing the final healing to be greatly delayed.

A J-shaped incision is made, with the long limb of the J surrounding the sinus, and the hook of the J curved towards the side from which the muscle-flap will be taken. This side should be that on which most muscle can be felt and least scar tissue is present. In *Case* 23, with a cavity in the head of the tibia, a chronic ulcer with much scarring was excised by a large oval incision, and, after inserting a flap from the inner head of the gastrocnemius, the wound was closed by turning down a skin-flap from the inner side of the thigh. As much scar tissue as possible is excised. This is the most tedious and difficult part of the operation. The periosteum round the cloaca into the bone is stripped back. The space between the muscle and bone is packed off with gauze to prevent pieces of bone, separated by chiselling, being left behind. Sargent emphasizes this point. The entrance to the cavity is then enlarged by the chisel.

FIG. 321.—*Case* 12. Multilocular type of cavity in middle of shaft of femur.

The cavities present are of two types. In the tunnel type (*Fig.* 319) there is a complete opening through the shaft of the bone. The base of the tunnel will be formed of fibrous tissue on the opposite side of the limb. The cylindrical tunnel is turned by the chisel into a funnel. A pyramidal-shaped muscle-flap can then be inserted right up to the apex of the funnel. In the other type (*Fig.* 320) there is only one opening into the cavity; and these are more favourable to treat. The upper and lower lips of the wall of the sinus are removed, so as to turn the cavity into a gutter. The lateral walls are preserved, to retain the cylindrical shape of the shaft of the bone and thus preserve its strength. This is an important variation of Broca's method, in which the cavity must be flattened out.

The cavity may be simple or multilocular. In the latter case (*Fig.* 321) the walls must be smoothed down by a gouge to make one large cavity. This is difficult in injuries like those in *Case* 7 (*Figs.* 322, 323), where there are long fissures running up the shaft of the bone. All granulation tissue is removed from the wall of the cavity. The complete sterilization of the cavity would appear to be impossible. In this series, the earlier cases were treated by cleaning the cavity with methylated spirit, and leaving in a B.I.P.P. pack while the muscle-flap was being cut. All the paste should then be wiped away, or the adhesions between the muscle-flap and the walls of the cavity will be delayed. In the later cases the cavity was washed out with hot saline, as advocated

by Sargent. Lefevre attempted to sterilize his cavities with hot air. All chips of bone must then be carefully sought for and removed from the wound. In a large wound they may easily be overlooked. In *Cases* 8 (*Figs.* 324–326) and 15, local abscesses occurred in the soft tissues shortly after healing of the wound. Both cases were due to a sequestrum lying outside the bone.

The second stage of the operation consists in dissecting back the deep fascia and exposing healthy muscle in the neighbourhood of the sinus. In a patient who had an ankylosed knee-joint, a U-shaped flap, consisting of deep fascia, muscle, and periosteum, as advocated by Af. Schultzen, was used. It was a failure. The flap was too rigid to fit

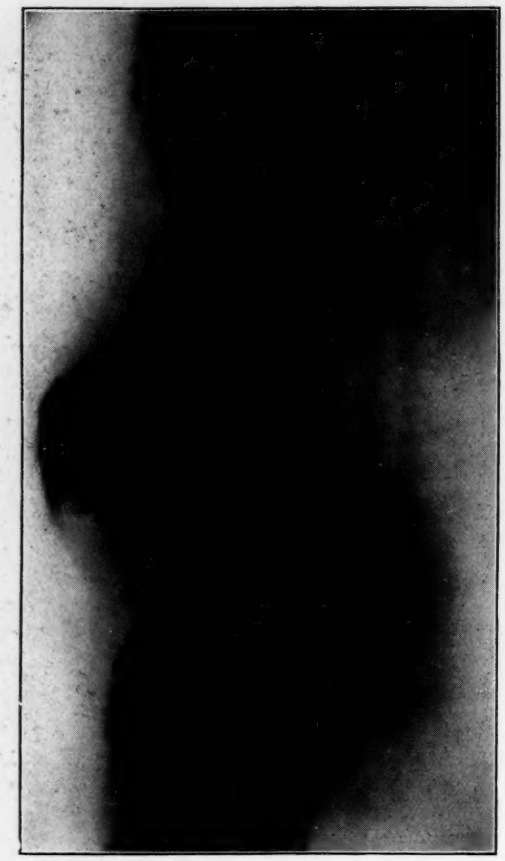

FIG. 322.—*Case* 7. Lateral view of lower third of femur, before operation.

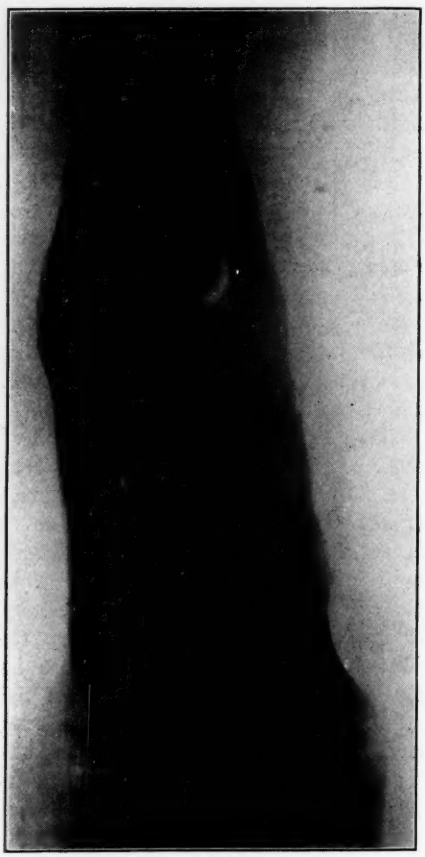

FIG. 323.—*Case* 7. Anteroposterior view of lower third of femur, showing cavity smoothed out at operation. A double flap was required to fill it.

the cavity accurately, thus leaving dead spaces behind. It also left a space between the skin and the place from which the flap was cut. In all the cases in this series one or two healthy muscle-bellies have been dissected out, and the deep fascia and periosteum have not been used.

The flap should preferably have its base above, as being easier to retain its blood- and nerve-supply. If this is anatomically inconvenient, the base may be made below as in *Cases* 1, 4, 9, and 10. In one of Af. Schultzen's cases, on account of the size of the cavity in the lower end of the femur, it was necessary to cut two flaps—one with its base above, and one with its base below. The inferior base-flap sloughed, the superior base-flap survived. The difference must have been in the blood-supply, and not in the amount

of sepsis present. Campbell and Pennefather have divided the muscles up into groups by their blood-supply. According to this classification, muscles such as the inner head of the gastrocnemius have a unipolar blood-supply. This muscle was used in *Cases* 21, 22, 23, and 24, the flap being cut with its base above. The muscles which were left with a base below have either belonged to the bipolar group, such as the biceps (*Case* 9), or the multipolar group, such as the vastus externus (*Case* 10) and the deltoid (*Case* 1).

The flap should consist of healthy muscle alone. Undamaged muscle is very mobile, and will fill the undulations in the cavity accurately. The length of the flap is cut so as to reach into the bottom of the cavity without tension. The contractile nature of muscle must be allowed for. Two or three catgut sutures fix it in position to prevent its displacement whilst sewing up the wound. If it is properly cut, there should be no tension, which would endanger its blood-supply.

If the cavity is very large (*Cases* 7 and 10) it is necessary to cut a second flap, the double-flap method. One flap is taken from the inner edge, and one from the outer edge of the wound. They may be cut—one with its base above and the other below, as in *Case* 10 (***Figs.* 327–329**), or both with their bases above, as in *Case* 7, where the semi-membranosus and the vastus internus were used.

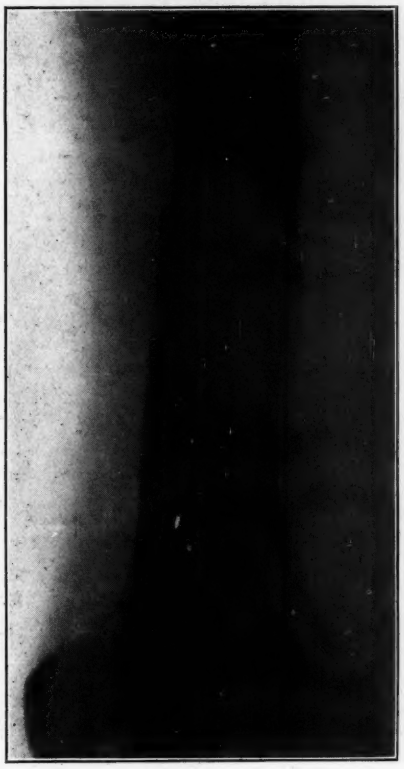

FIG. 324.—*Case* 8. The arrow points to sequestrum left behind at muscle-flap operation.

The situation of the flaps should be such that, when cut, they fall laterally into the cavity. In some cases it is necessary to turn the flap at a right angle, but an acute angle should be avoided, as liable to constrict the blood-supply. For a cavity in the upper end of the humerus the deltoid is chosen, preferably its anterior portion, as less likely to interfere with its nerve-supply (*Cases* 1 and 2). If the cavity is rather low down the humerus, tension of the flap may be avoided by putting the arm on an abduction frame. For the shaft and lower end of the humerus a portion of the triceps is used (*Case* 3). The radius and ulna rarely require this operation. A lesion sufficiently severe to produce a large cavity will usually result in a complete gap in the bone. In *Case* 4 the upper end of the ulna was united by a bridge to the radius. A cavity was left between the lower fragment of the ulna and this bridge. It was fitted by a flap cut from the upper end of the extensor carpi ulnaris. This muscle was chosen as least likely to interfere with the function of the hand. For the ilium, the gluteus maximus is usually accessible (*Case* 5). The muscles round the shaft of the femur are very suitable for flaps. They have long bellies, and can be cut to the required length, thus avoiding tension. The vastus externus (*Cases* 6, 8, 10, 12, 14, 15, 16, 17, 18) should be chosen when possible: it is bulky; the action of its whole is not seriously impaired by using part of the muscle; it is not intimately connected with important nerves or arteries—a great help where much scar tissue is present (*see Figs.* 330, 331). In *Case* 11 it was not available, being fibrous and bound down to the femur. The biceps was used to fill the cavity. Just above the condyles the vastus externus is too tendinous to be satisfactory.

A sinus on the inner side of the femur is fortunately much rarer than on the outer side; this is no doubt due to the tendency of surgeons operating on the primary wound to drain on the outer side of the limb. Contact with the femoral vessels was thus avoided

by the large drainage tubes which were used at one period of the war. In *Cases* 7 and 13 the sinus was present on the inner side of the thigh. The semimembranosus was used to close the cavity. The objection to this muscle is its relatively small width. This difficulty was overcome by using a second flap from the vastus internus. Af. Schultzen's method of approaching the cavity from the other side of the femur would have so seriously weakened the shaft of the bone in this case as to be impracticable.

For the upper end of the tibia (*Cases* 21, 22, 23, 24) the inner head of the gastrocnemius is used. It is preferable to the soleus on account of its higher origin. This allows

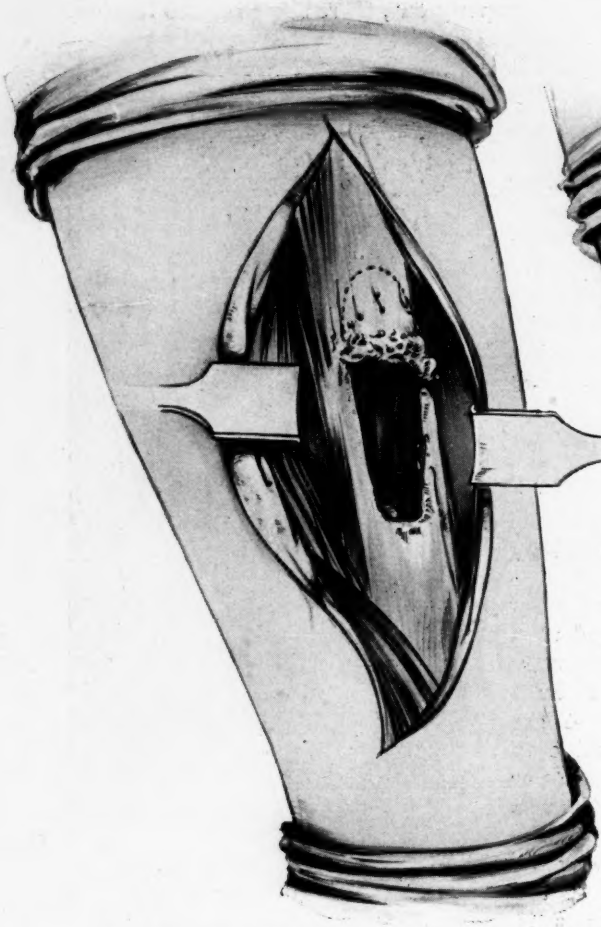

FIG. 325.—*Case* 8. Gutter type of cavity in femur. Dotted line shows amount of bone requiring removal.

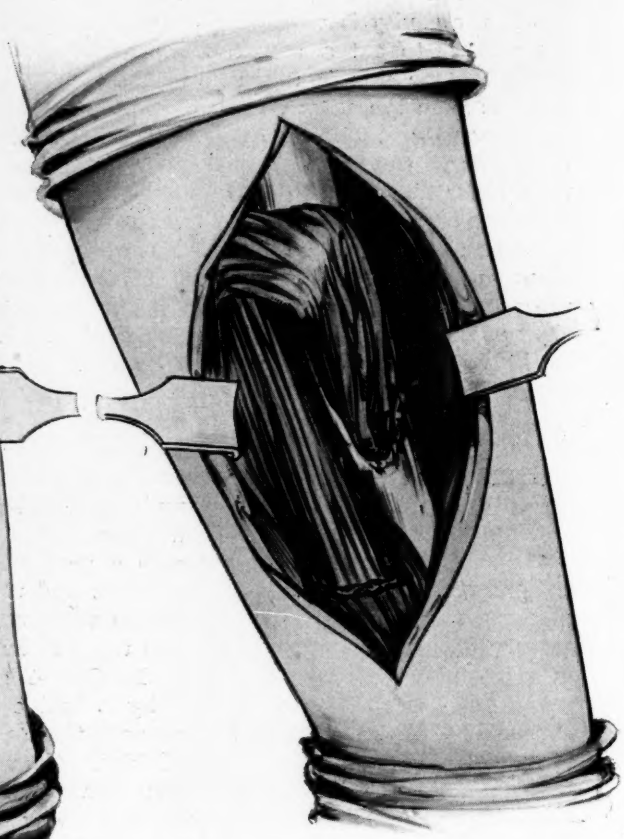

FIG. 326.—*Case* 8. Cavity filled by single flap from vastus externus with its base above.

a more mobile flap to be cut with its base above, the cavity usually being in the head of the tibia. When the entrance is on the outer side of the shaft of the tibia, no muscle is available. The anterior tibial group is not bulky enough, and, on account of its close relation to the bone, tends to be involved in scar tissue. It is necessary to approach the cavity through its intact inner wall; the inner head of the gastrocnemius then becomes available. The resulting weakness to the shaft of the tibia is of less importance than in the femur on account of its fibular support (*Case* 21, *Figs.* 332–335). The cavity being filled with a muscle-flap, a rubber-glove drain is placed on the superficial surface of the flap to allow any exudation to escape. No drain is placed in the bone cavity. The deep fascia is

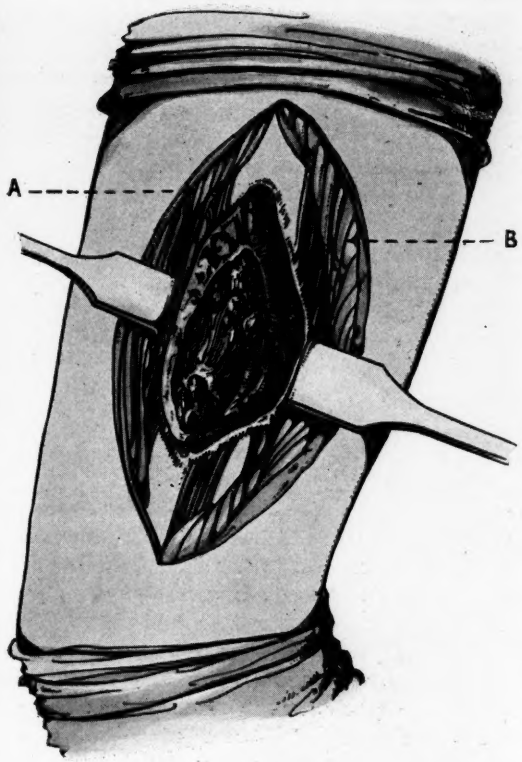

FIG. 327.—*Case* 10. Cavity exposed through outer wall of femur after excision of scar tissue. A, B, Vastus externus.

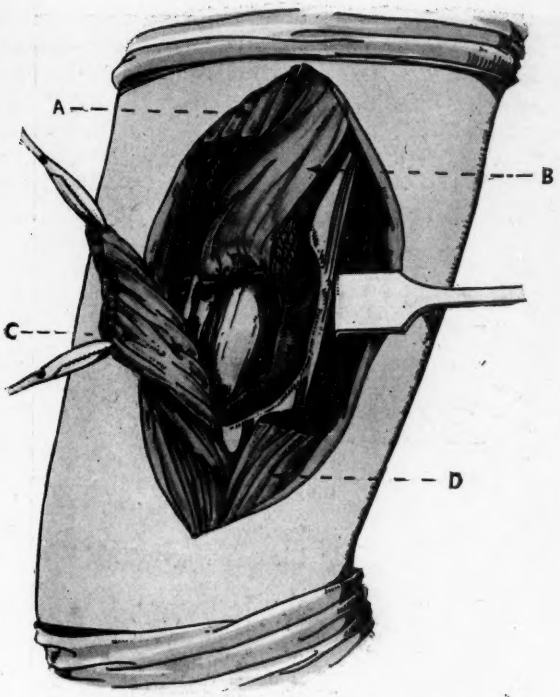

FIG. 328.—*Case* 10. A, C, Cut ends of vastus externus anterior to femur. B, D, Cut ends of vastus externus posterior to femur. The first flap (B) inserted in cavity.

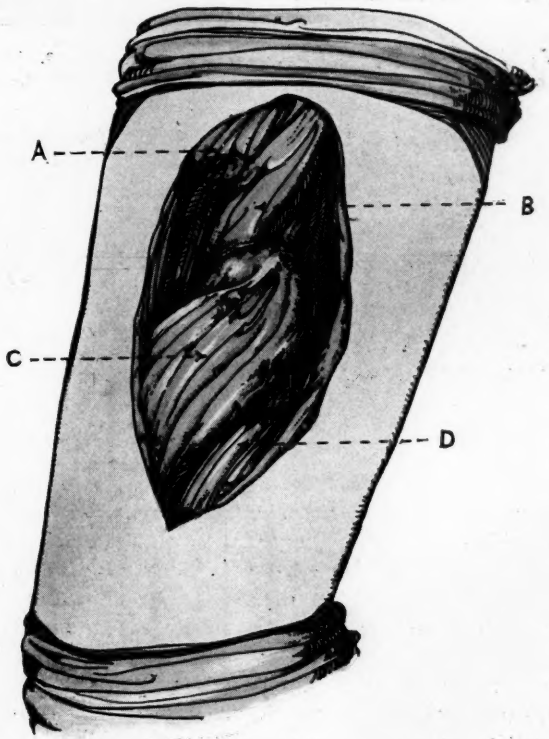

FIG. 329. *Case* 10.—C, The second flap, with its base below, inserted in cavity.

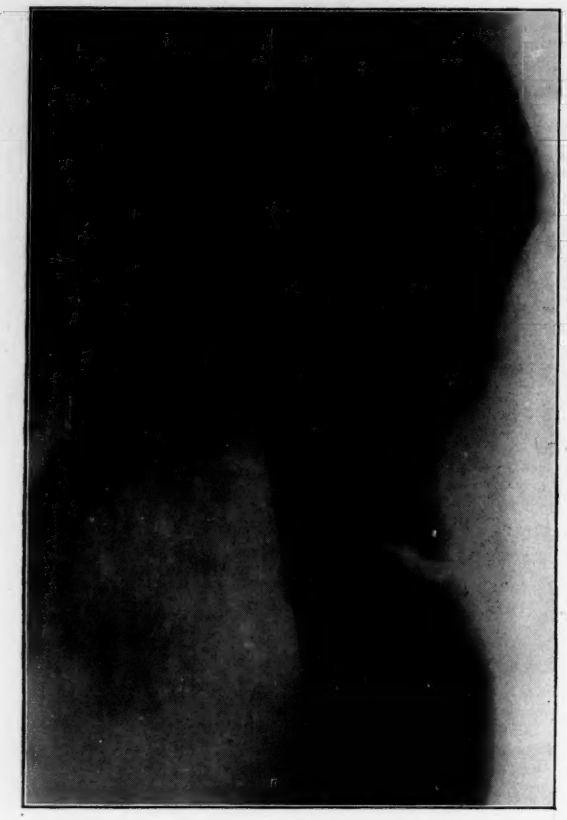

FIG. 330.—*Case* 19. Cavity in outer wall of femur, before operation.

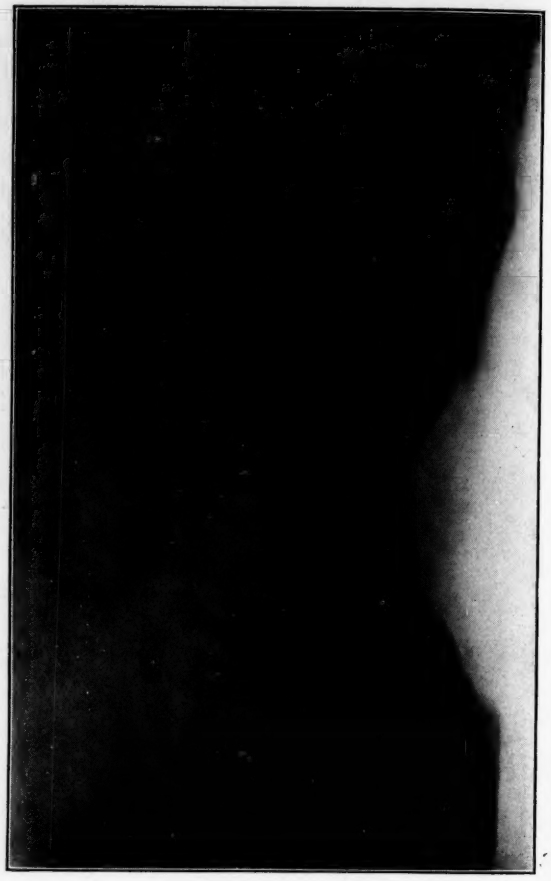

FIG. 331.—*Case* 19. Upper third of femur after operation. Vastus externus inserted in cavity.

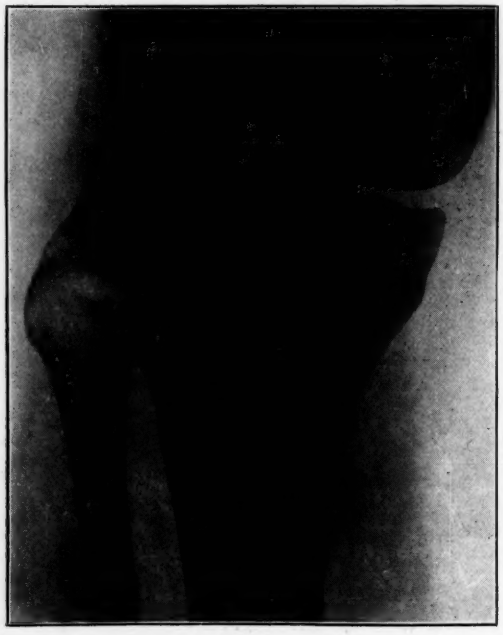

FIG. 332.—*Case* 21. Cavity in head of tibia, before operation.

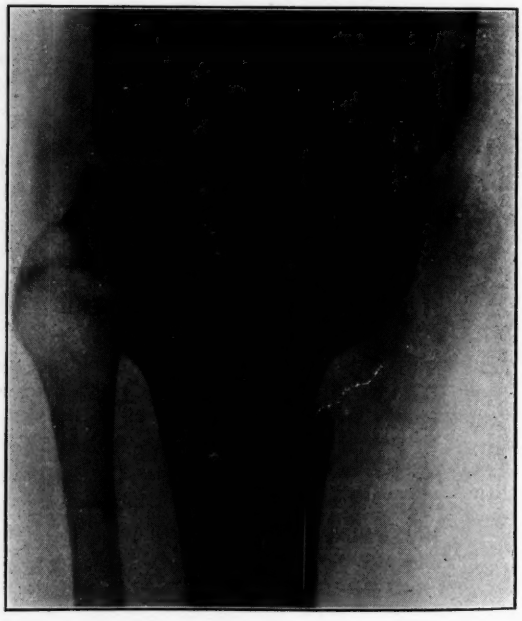

FIG. 333.—*Case* 21. After operation, showing method of approach to cavity for inserting gastrocnemius.

resutured in position by catgut. The skin is closed with silkworm gut. A lightly bandaged dressing of gauze and wool is applied, and a wooden splint for the first four days to keep the neighbouring joints at rest. Af. Schultzen devised a wire cage to stand over the wound to prevent pressure of the dressing causing anæmia of the flap. Probably the reactionary œdema of the tissues inside the limb is more to be feared than light pressure from without.

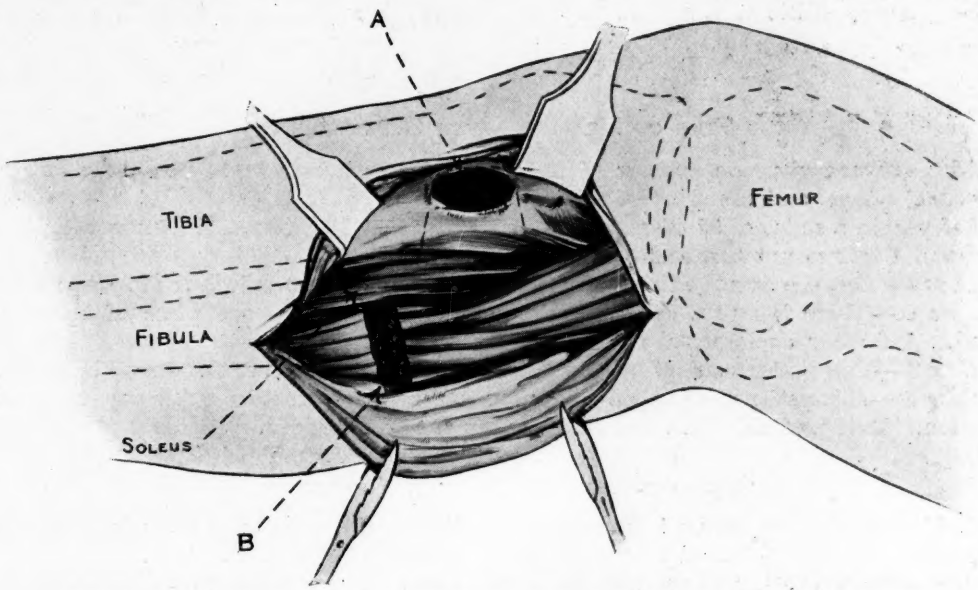

FIG. 334.—*Case* 21. **A**, Cavity on inner side of head of tibia. **B**, Flap from inner head of gastrocnemius.

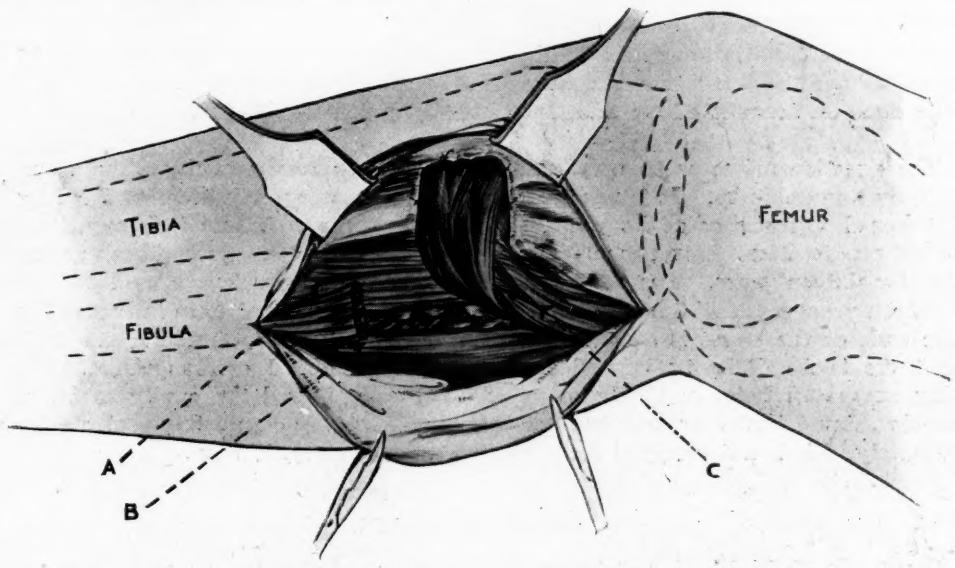

FIG. 335.—*Case* 21. **A**, Soleus muscle. **B**, Gastrocnemius. **C**, Flap from gastrocnemius inserted into cavity.

Lefevre found his best results with the humerus and his worst with the femur. In most cases there is an inflammatory reaction in the wound, at its worst on the fourth day. One or two stitches may require removal. In no case in this series has the flap sloughed. In two instances (*Cases* 11 and 20) the wound healed by first intention.

The average time taken for each operation is one and a half hours.

Bones involved	Cases	Healed
Humerus	3	1
Ulna	1	1
Ilium	1	1
Femur	15	14
Tibia	4	4
Total	24	21

Time of Healing after Operation.

Af. Schultzen gives an average of forty days for each case in 14 cases, the longest being ninety days, and the shortest thirty.

Lefevre, in a series of 53 cases, had 12 h aled by first intention, 26 in one month, 3 in six weeks, 4 in two months, and 8 failures.

In my series, the average time was forty days. There were 3 failures, as follows :—

Case 2.—There is still a sinus present, probably due to a small piece of bone left behind. A further exploration will be necessary.

Case 3.—This patient cannot be traced. It is not known whether the wound is healed.

Case 6.—This patient had to leave the hospital for family reasons a few days after the operation. It is probable that the flap became partly dislodged.

Contra-indications to the Operation.

1. If a cellulitis or active inflammation of the muscles round the sinus is present, a preliminary drainage followed by Carrel-Dakin treatment should be given.

2. Excessive wasting of the muscles of the limb. In cases due to gunshot wounds, the wasting is usually only localized, and due to destruction of the muscle by the missile. In old cases of osteomyelitis in children, general wasting of the limb may be a bar to a sufficiently bulky muscle-flap.

3. If no muscle is available locally for anatomical reasons. The lower end of the tibia is the most striking example, but here Broca's method of flattening out the cavity can be done on account of the additional support given by the fibula.

The question arises as to what eventually happens to the cavity after a successful closure by a muscle-flap. It is very unlikely that the cavity ever becomes filled by bone. The lessened vascularity of its walls, which follows from chronic inflammation, limits bone-cell proliferation. Sargent quotes a case in a man, age 50, who had been under observation for sixteen years. The cavity was originally 4 inches in length, and at the end of the sixteen years was still 3 inches long. That new bone will not form in cases of sclerosis of the ends of the bones is shown in many cases of non-union of fractures. In healthy bone there is no difficulty in replacing artificially removed osseous tissue. Bancroft, having excavated holes in the humerus of dogs, and allowed the cavity to fill up with blood-clot, found that four months later this blood-clot was completely replaced by bone. Fortunately, this is not essential for a good functional result in man.

NOTES OF CASES.

Case 1.—F. H. W. W. Gunshot wound of the upper end of humerus ; tunnel type. Wound discharging 4 years 8 months. Filled by a flap from the anterior part of the deltoid muscle. Healed in 18 days.

Case 2.—W. J. S. Gunshot wound of the upper end of humerus, with bony ankylosis of shoulder-joint ; tunnel type. Discharging 2 years 2 months. A flap taken from posterior part of the deltoid, as the anterior portion was absent. Did not heal. At a second operation a previously overlooked sequestrum was removed.

Case 3.—A. C. R. Gunshot wound of the middle of the humerus ; gutter type. Discharging 2 years 1 month. Flap from the inner head of the triceps. Failure.

Case 4.—S. H. E. Gunshot wound of the upper end of radius and ulna ; cavity between the lower fragment of the ulna, and the bony bridge joining radius and ulna. Flap from the extensor carpi ulnaris. Sinus, which had been discharging 2 years 2 months, healed in 33 days.

Case 5.—H. U. N. Gunshot wound of the ilium near the sacro-iliac joint. Discharging 2 years 2 months. A muscle-flap from gluteus maximus. Healed in 49 days.

Case 6.—W. M. Gunshot wound of the upper third of the femur. Discharging 4 years 7 months. A muscle-flap from vastus externus. Failure.

Case 7.—A. J. H. Gunshot wound of the lower third of femur. Large cavity. Discharging 2 years 1 month. A double flap of semimembranosus and vastus internus, with their bases above, was used. Healed in 74 days. A bacterial count showed 2 staphylococci per field, at the time of operation.

Case 8.—C. G. S. Gunshot wound of the middle of femur. Discharging 1 year 8 months. A muscle-flap from vastus externus. Healed in 14 days. A subsequent abscess caused by a piece of bone left behind at operation : this was removed. Wound then healed soundly.

Case 9.—W. G. M. B. Gunshot wound of the lower third of the femur. Discharging 4 years 5 months. Flap cut from biceps, as quadriceps was chiefly fibrous tissue at this level. Healed in 49 days.

Case 10.—S. A. U. Gunshot wound of the middle of femur. A large ivory peg had been inserted 9 months later ; the wound did not heal, and had been discharging 2 years 3 months. Sound union of femur. Sinus led down to a large peg, which was removed and the cavity filled by a double flap from the vastus externus. Healed in 33 days.

Case 11.—W. W. Gunshot wound of the lower third of the femur. Discharging 1 year 5 months. Sequestrectomy. Cavity filled by a biceps-flap. Healed by first intention.

Case 12.—B. U. R. Gunshot wound of the middle of the femur. Discharging 1 year 6 months. Cavity multilocular. A muscle-flap cut from vastus externus. Healed in 28 days.

Case 13.—T. A. Y. Gunshot wound of the lower third of the femur. A large multilocular cavity. Discharging 1 year 8 months. Cavity filled by semimembranosus muscle. Healed in 79 days.

Case 14.—P. E. D. Gunshot wound of the middle of the femur ; tunnel type. Discharging 3 years. A muscle-flap from vastus externus. Healed in 21 days.

Case 15.—H. S. J. R. Gunshot wound of the middle of the femur. Discharging 3 years 9 months. A flap from vastus externus. Healed in 90 days.

Case 16.—R. C. Gunshot wound of the lower third of the femur. Discharging 3 years 1 month. Albuminuria present. Cavity filled up by a flap from the biceps. Healed in 34 days. Albumin in urine disappeared.

Case 17.—O. R. Gunshot wound of the middle of the femur. Sinus discharging 4 years 6 months. Patient had been operated on fourteen times before admission. Operation in two stages, because of much pus present in cavity. A flap from the vastus externus inserted at second stage. Wound has not healed.

Case 18.—A. K. Gunshot wound of the lower third of the femur. Discharging 4 years 3 months ; gutter type. A flap cut from the quadriceps. Healed in 50 days.

Case 19.—H. A. R. Gunshot wound of the upper third of the femur. Discharging 2 years 1 month. A flap from the vastus externus, with its neck above. Healed in 50 days.

Case 20.—C. T. F. Gunshot wound of the lower third of the femur. Discharging 4 years 3 months. Cavity filled by the sartorius. Healed by first intention.

Case 21.—J. W. D. Gunshot wound of the head of the tibia. Discharging 1 year 9 months. A long flap was taken from the inner head of the gastrocnemius, and this had to be introduced into the cavity through the inner wall of the tibia. Healed in 56 days.

Case 22.—G. H. C. Gunshot wound of the head of the tibia. Discharging 6 years 10 months. A flap cut from the inner head of the gastrocnemius. Sloughing of the part of skin followed its undermining. Healed in 42 days.

Case 23.—S. T. O. Gunshot wound of the head of the tibia. Discharging 4 years 1 month. A large ulcer was present; ulcer excised. The bone cavity was filled by a flap from the inner head of the gastrocnemius. Skin closed by a pedicled skin-flap, turned down from the lower third of the thigh. Healed in 28 days.]

Case 24.—B. B. Gunshot wound of the head of the tibia. Discharging 3 years 4 months. A flap from the inner head of the gastrocnemius. Healed in 56 days.

I am indebted to Mr. E. W. Hey Groves for his help, and for many suggestions in this work; and also to Miss D. Pillers for the drawings.

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VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

SIR WILLIAM THORBURN'S CLINIC AT MANCHESTER.

In 1909 the new hospital was opened in Manchester. This magnificent building, which should be seen by all, and especially by those interested in the planning of an up-to-date hospital, was the outcome of much thought and labour devoted by Sir William Thorburn. It was he who conceived and effected the principle of the establishment of complete surgical in-patient units. Thus, in one block of buildings and on the same floor one finds wards for male and female patients, each ward having its own separate rooms

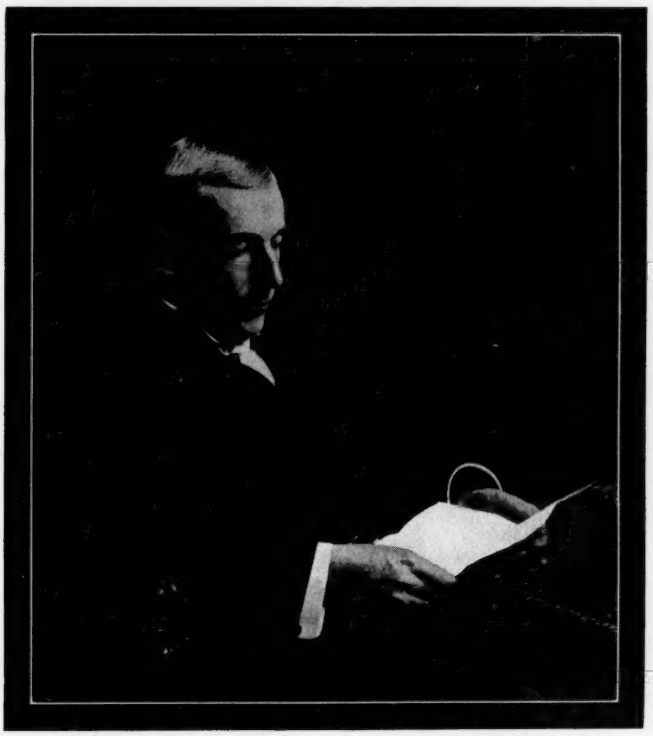

Fig. 336.—Sir William Thorburn, K.B.E., C.B., C.M.G.

for the isolation of cases; a theatre block consisting of the surgeon's room, where records are kept, a room for the administration of the anæsthetic leading into the theatre, which connects with a large sterilizing annexe; and a recovery room used, if required, for resuscitation purposes.

There are five such surgical units, and, although in some cases units are on different floors above each other, by a clever architectural device the theatres have been provided with proper illumination by means of a top light in each case. It must be a great satisfaction to Sir William Thorburn, when looking back on those days of arduous toil in which

this hospital was planned and built after his own design, to see now the smooth working of the hospital which his forethought has rendered possible.

In another part of the building are the premises set aside for the School, including—as well as common-rooms, library, class-rooms and laboratories—a fine lecture theatre.

Professor in Surgery to the University, Sir William Thorburn has given in this theatre many lectures and demonstrations; and, though now he has formally retired from the active staff of the hospital, he has acceded to the request of his colleagues to give from time to time a course of lectures on some selected subject. His teaching in clinical surgery is of an attractive type: he faces the problem from the students' point of view, and, by analyzing the subject and presenting each member of his audience with a 'schematized' chart at the beginning of each lecture, he creates and maintains an interest. It is characteristic that he will not draw pictures, but he will, and invariably does, build up diagrams easily visualized, and bearing only essential features.

On the writer's introduction to the clinic, he was fortunate enough to find the unit engaged in the operating theatre, and a description of the morning's work will serve to indicate the general arrangements and technique. The first case was brought to the anæsthetizing room in bed, by means of a trolley (*Fig.* 337), which is first wheeled into position under the bed, its framework then being elevated by a simple movement of a lever which raises the bed from the floor. The use of these trolleys, which were seen by Sir William Thorburn in Stockholm and brought to this country, has many advantages over the method of moving a patient by transference to a wheeled stretcher: a minimum of lifting is effected before and after operation; a patient is settled comfortably in bed directly after an operation, the operating table being wheeled into the anæsthetizing room where the bed has been kept, and a single lifting from the table to bed is the only disturbance to which the patient is subjected. In the anæsthetizing room the patient was transferred to the operating table and placed, prior to the induction of anæsthesia, in the position to be maintained during the operation.

FIG. 337.—Bed trolley.

Here one had the pleasure of meeting Sir William Thorburn's friend and colleague, Mr. Wilson, who for many years has been the anæsthetist to the clinic. One appreciated the advantages under which these two men worked, each devoting his attention to the task in front of him, yet ever mindful of the other. This close association of two old friends in their respective branches of surgery must on many difficult and tiring occasions have lightened their burden and added to the efficiency of their work.

Case 1.—Operation for injury to the brachial plexus involving the upper trunk—right side.

Six months before operation the patient sustained an injury to his right shoulder, being pitched from a motor-bicycle. As a result he developed, without signs of fracture or dislocation, a paralysis of certain muscles of the upper limb, namely, supraspinatus, infraspinatus, deltoid, and biceps; there was no paralysis of the rhomboid muscles. A curved incision, crossing the lower part of the posterior triangle of the neck, was made, the incision being first outlined and cross-marked with the point of a cutting needle. After division of the platysma a considerable mass of scar tissue was encountered. A careful

dissection was made, exposing the upper trunk of the brachial plexus, which was found to be bulbous at the junction of the 5th and 6th cervical nerves. Further dissection freed the trunk with its bulb from the surrounding scar tissue, which was extremely dense. The bulb itself was dissected, and there was found embedded in its substance a shell of bone, sufficient in size to enclose the original nerve-trunk on its front and lateral aspects. This piece of bone, which, after removal, had all the appearances of having come from the posterior aspect of the clavicle, was dissected out with its enclosing scar tissue, and a groove in the nerve where this foreign body had lain was evident. After its removal, however, the whole nerve-trunk became more mobile and normal in appearance, the groove becoming gradually obliterated. It was therefore decided not to resect any portion of the nerve, and the wound was closed in layers with catgut sutures, finishing with a fine continuous suture of horse-hair (to be removed on the following day).

Case 2.—Operation for causalgia, the result of an old gunshot wound of the axilla involving the brachial nerves—left side. This patient had suffered from intense pain in the hand and forearm since being wounded in the early days of the war. The hand and arm were useless from contractures following injury to the median and ulnar nerves. Two operations upon the nerves themselves had proved unsuccessful.

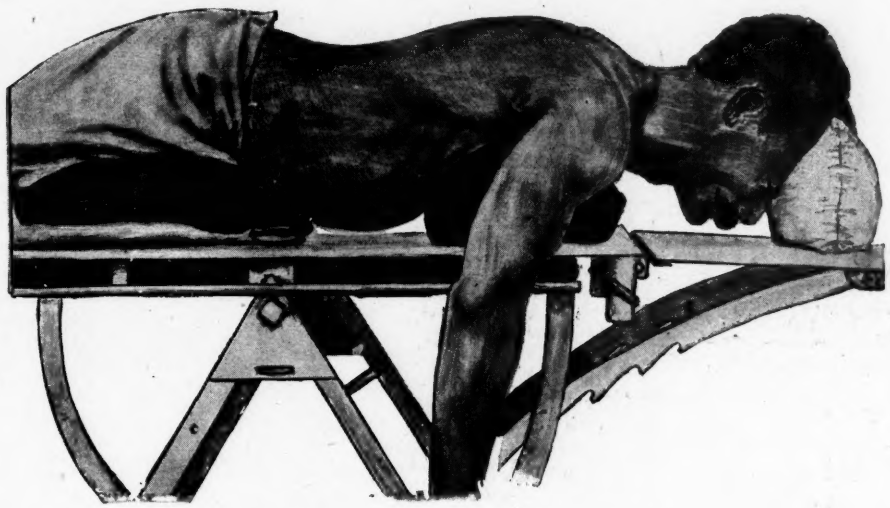

FIG. 338.—Position of patient for laminectomy.

The patient was in the prone position (*Fig.* 003) (I had previously found Mr. Wilson himself testing the comfort of the position in which this patient was to lie). A vertical incision in the middle line was made over the spinous processes of the lower cervical and upper thoracic vertebræ, the spinous processes were cleared on each side, the interspinous ligament between the lowest two exposed spines was divided, and the processes were severed from the laminæ. These processes, still attached to each other and above to the remaining spinous processes, were folded upwards (to be subsequently replaced). The laminæ were then cleared and, with a laminectomy saw, divided on each side and removed. The dura mater was cleared and opened, being held open by means of retracting sutures passed through the cut edges.

The posterior roots of the 6th, 7th, and 8th cervical and 1st thoracic nerves were then identified, isolated, and divided close to their attachment to the cord.

The dural opening was closed with a continuous catgut suture, and a layer of the deeper muscles was joined over the dura by means of interrupted catgut sutures. The spinous processes were replaced to lie on this deep layer of muscle. The more superficial muscles were then united over the spinous processes, sutures being passed so as to retain the processes in position. Finally, the skin was closed with interrupted salmon-gut sutures.

Although the patient was a stout and muscular man, bleeding was readily controlled by occasional pressure and packing.

The various stages of the operations and the practical points arising out of them were explained, as the operation proceeded, for the benefit of the students present. Nor did the interest flag in the short interval between the operations, during which the students were regaled with instructive and amusing anecdotes.

In the theatre technique, the theatre sister plays a prominent part: to her is entrusted the management of the instruments, sutures, swabs, and dressings; but although this all-important function rests with the sister, it is the practice to train all dressers of the unit in that work. The principal assistant at the operation is the house surgeon, with a dresser as an additional assistant. The principles of aseptic technique

FIG. 339.—New Hospital, Manchester.

are conscientiously adhered to, and, as a detail of dress, the spectacle-frame type of mask is worn, from which is hung a wide piece of stout gauze.

Among the cases seen in the wards, the following are of exceptional interest:—

Two cases of intrathecal spinal tumour in the upper and lower thoracic regions respectively: in each case laminectomy with removal of the tumour had been performed. These patients were in perfect condition, and had no incapacity whatsoever from their laminectomy. The spinous processes had been left *in situ* as in the operation described above; further, they had both made remarkable recoveries with regard to their spinal lesions.

A case of locomotor ataxy with gastric crises: in which laminectomy, with division of the posterior roots of the 6th to 11th thoracic nerves, had been performed some years ago, with complete relief of pain.

Two cases of trigeminal neuralgia : in which the Gasserian ganglion had been removed, with complete cure. Both these patients, though one is over 60 years of age, are now doing a full day's hard work.

A case in which subtemporal decompression on the left side had been performed for an unlocalized cerebral tumour.

A case of Jacksonian epilepsy : in which a left-sided tumour in the Rolandic area had been removed. Some temporary aphasia and right hemiplegia had followed the operation, but soon cleared up, and the patient made a complete recovery. In this case a bone-flap was cut and replaced.

A case of double cervical ribs, both of which had been removed, followed by complete relief of symptoms.

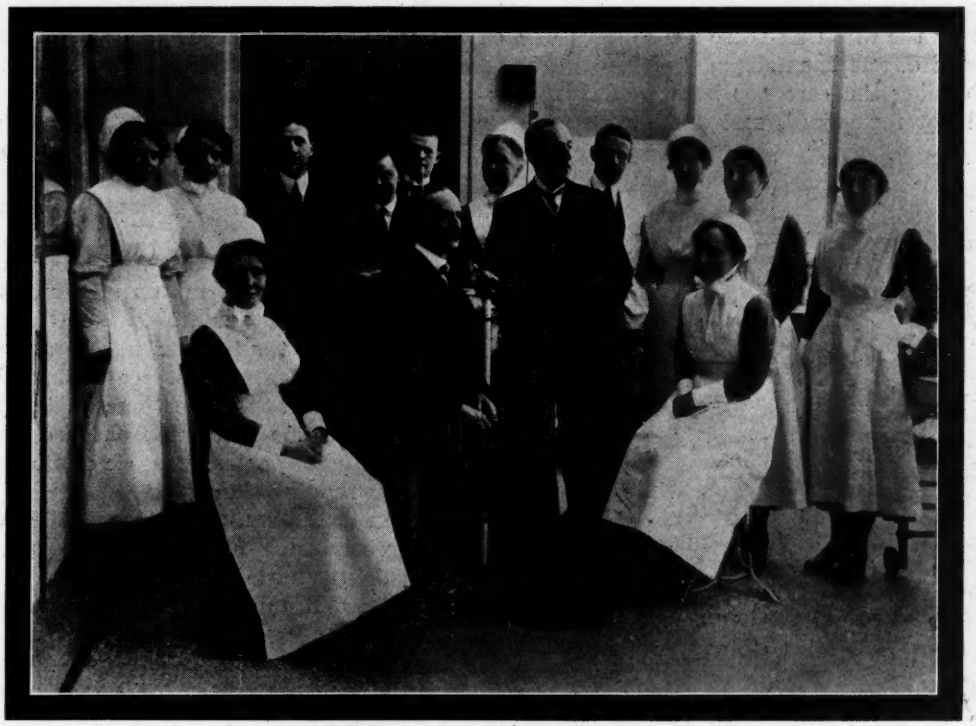

FIG. 340.—Group of members of the clinic.

The writer's thanks here are due to Sister Gordon, sister in charge of the ward for female patients, for the trouble she took to collect the cases for inspection and for the facilities she provided for their examination. One was privileged to observe again that bond of friendship and devotion between sister and surgeon, strengthened by many years of strenuous work, and directed towards one common object, the comfort and well-being of their patients.

It happens that the cases mentioned in this account belong to the field of neurological surgery in which Sir William Thorburn has done so much pioneer work. It was his investigations which established the details of the segmental distribution of the spinal cord in man ; but it is to be remembered that he has not allowed this branch of surgery to restrict his researches and progress in other more general lines of surgery, as his teaching and writings on various topics have shown.

A CASE OF PERSISTENT VITELLINE ARTERY: FATAL INTRA-ABDOMINAL HÆMORRHAGE FROM RUPTURE OF THE VESSEL.

By JOHN FRASER and J. E. McCARTNEY, Edinburgh.

We believe that for several reasons there is sufficient justification to warrant the publication of the following case. The condition is one of considerable rarity, as is borne out by the fact that there are so few recorded examples in the literature. It is of interest from a developmental point of view. The reason, however, which really influenced us in publishing the case has been a clinical one: it illustrates a danger which previously we had not recognized, and it demonstrates how very narrow may be the margin between success and failure in what appears to be the simplest type of case.

Fig. 341.—The appearance of the condition as revealed at post-mortem examination. A, Portion of anterior abdominal wall; B, Persistent vitelline artery; C, Subperitoneal hæmorrhage.

Baby J. W. Age 4 months. Admitted Sept. 18, 1920.

History.—The baby was brought to hospital by the parents on account of a small tumour at the umbilicus. Attention was drawn to the tumour, not on account of its size, which was no greater than that of a pea, but because there was a persistent irritating discharge from its surface, which tended to produce excoriation of the surrounding skin.

On Examination. — The child was apparently healthy. At the umbilicus, and slightly buried within its folds, there was a small tumour the size of a pea, composed, one would say, of granulation tissue, and growing by a narrow pedicle from the deeper portion of the umbilicus. Its surface gave rise to a small amount of secretion. There was no sign of any cavity in its interior, and it did not appear to connect with any deeper abdominal structure. The condition was regarded as that of a simple umbilical granulation.

Subsequent History. — These conditions have always been treated upon the simple lines of touching the pedicle with the actual cautery, and this treatment was adopted in the case under review. The tumour was lifted from the umbilicus, and the pedicle was divided with the cautery. The condition was looked upon as entirely a minor one, but, as the child was a country case, it was admitted for a few days to the hospital wards. As events turned out, this was a fortunate occurrence. The child remained well for twenty-four hours, but after this period it began to show certain alarming features. The first intimation of anything wrong was several attacks of sickness. Gradually it became quite clear that the child was gravely ill. The pulse increased in

rapidity, and the appearance was one of considerable shock. It was very difficult to ascertain the origin of these alarming symptoms. There was no sign of any peritonitis. There was no obstruction; the bowel had moved in connection with the administration of rectal salines; and, to be correct, no actual diagnosis was come to beyond one of delayed shock. Unfortunately, the child succumbed within forty-eight hours of the original operation. The explanation is detailed in the following facts.

Post-mortem Examination. (*Fig.* 341).—On opening the abdomen, the peritoneal cavity was seen to contain a large quantity of blood, of which about four ounces were in the pouch of Douglas. There was no evidence of peritonitis or of perforation. A thin fibrous cord, one and a half inches long, stretched from the umbilicus a little to the left of the middle line, to the mesentery of the ileum, about eighteen inches from the ileocæcal valve. The actual attachment of this cord to the mesentery, which appeared to be half an inch from the gut wall, was hidden by a hæmatoma in the mesentery. This hæmatoma was about an inch in diameter, and at the apex was a small hole from which the blood had escaped into the peritoneal cavity. The other organs of the body showed nothing worthy of note.

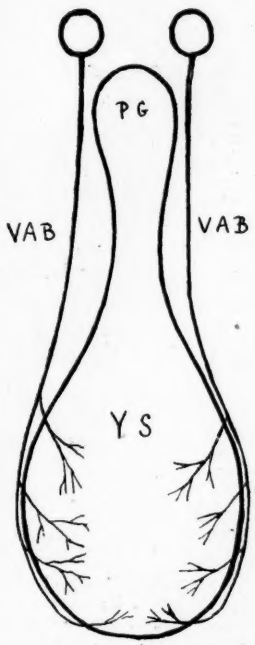

FIG. 342.—Primitive gut and yolk sac with the two ventral aortic branches ramifying *on* wall of yolk sac.

On dissecting the cord through the hæmatoma, it was found to be attached to a branch of the superior mesenteric artery. This shows that the cord was the persistent left vitelline artery. Its lumen was completely obliterated, even at the junction with the superior mesenteric branch. Opposite the attachment of the vitelline artery there arose from the superior mesenteric artery a small branch which had been torn across, and this was responsible for the hæmorrhage.

During the operation, on lifting the tumour from the umbilicus, traction was exerted on the vitelline artery and, through it, on the main vessel, thus causing the rupture of the small branch. As a result, a hæmatoma was formed in the mesentery, and after this had attained a certain size, the stretched peritoneum over it ruptured, and blood escaped into the peritoneal cavity.

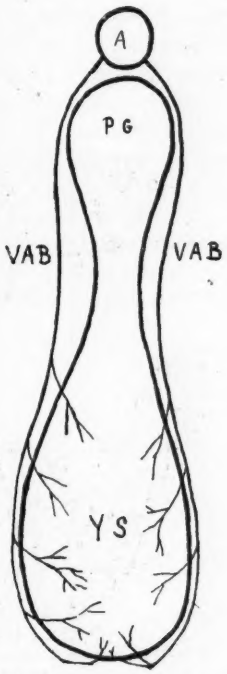

FIG. 343.—A later stage than *Fig.* 342. The two vitelline arteries taking origin from aorta.

It is interesting to consider briefly the development of this condition. In the embryo, the vitelline arteries arise as two ventral aortic branches, which ramify in the wall of the yolk sac (*Figs.* 342, 343). These vessels then fuse to form a short common trunk, which later becomes the superior mesenteric artery. One of the ventral aortic branches persists as the definite vitelline artery, and proceeds round the gut wall along the vitelline duct to the yolk sac (*Fig.* 344). Later, when the intestines are entirely within the abdomen, the vitelline duct ceases to exist, and the vitelline artery is stretched to a filamentous strand, so that it normally ruptures and disappears. In this case, however, the artery had persisted, and the tension caused it to be pulled away from the gut wall, so that the artery emerged from the peritoneum at its junction with the superior mesenteric artery without being adherent in any way to the wall of the bowel.

Fig. 345 shows diagrammatically the anatomical relations in the present case. The fibrous cord must have been under tension at the time of the operation, as the small amount of pull on the tumour was sufficient to rupture the small branch at the junction.

Discussion.—No similar case has been found in the literature. The occasional persistence of vitelline arteries was known to Meckel, who says "that in man as well as in animals, the remains of the vitelline canal disappear earlier from the intestine than from the vascular systems". He also quotes a case where, in a child of three months, he found a persistent vitelline artery arising from the superior mesenteric artery, and proceeding along the entire length of a Meckel's diverticulum, and which was "converted at its end into a solid thread several inches long, and hanging free."

Spangenburg found in a young man twenty years of age a persistent vitelline vein, which was patent from the mesenteric vessel for half its length.

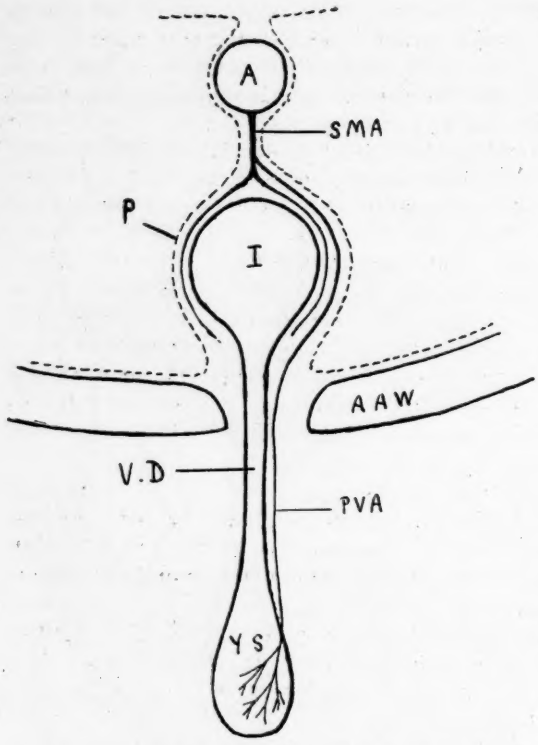

FIG. 344.—The two vitelline arteries have fused to form the superior mesenteric artery (S.M.A.). The right artery below the junction has disappeared, the left (P.V.A.) runs along the vitelline duct to the yolk sac. At this stage it is close to the gut wall, and under the peritoneum.

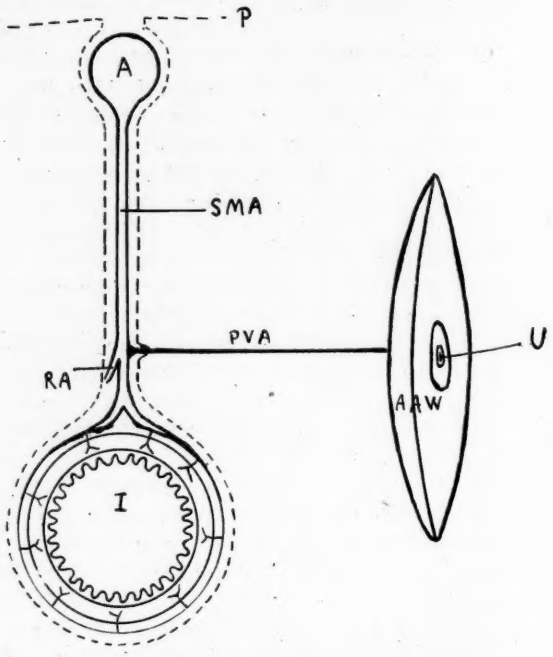

FIG. 345.—The condition existing in the described case. The relation of the peritoneum is shown by the dotted line. The persistent artery (P.V.A.) is connected with the anterior abdominal wall and with the superior mesenteric artery. The small ruptured branch is shown at R.A.

Eschrict records a fatal case of strangulation of the bowel in an old woman, due to a persistent omphalo-mesenteric vessel. The importance of these persistent vessels in causing strangulation has been emphasized by Falk, Schroeder, and Leichtenstein, who quote cases.

A comprehensive account of persistent omphalo-mesenteric remains is given by Fitz,[1] from whom the above references are quoted.

Our thanks are due to Professor Arthur Robinson for assistance in connection with the developmental aspects of the case.

REFERENCE.

[1] FITZ, *Amer. Med. Journal*, 1884, lxxxviii, 30.

CAPILLARY ANGEIOMATOSIS OF THE PAROTID GLAND (PARTIAL EXCISION).

By CLEMENT NICORY, London,

WITH A PATHOLOGICAL ACCOUNT AND REMARKS

By Professor S. G. SHATTOCK, F.R.S.

The condition to be described is of interest from both a clinical and a pathological point of view. The patient, a male infant, age 9 months, was seen by me as an out-patient at the Evelina Hospital, London. The child was of normal development, and had given no difficulty since birth. When it was six weeks old the mother accidentally noticed a round lump, about the size of a marble, in the right parotid region. The swelling was said to have gradually increased, and when seen there was a marked prominence on the right side of the face, about the size of a bantam's egg, corresponding anatomically with the parotid gland. The skin over its most prominent part showed a slight bluish-red tint produced by a few small superficial vessels. There were no signs of inflammation, and the skin was freely movable over the elevation. On palpation the tumour felt uniformly soft and elastic, but without definite fluctuation. It was not movable on the deep structures, and yielded no pulsation.

From within the mouth the tumour gave a similar impression. The opening of Stenson's duct appeared normal; no fluid was seen to exude on applying firm pressure to the mass. There was no history of constitutional disturbance, or pain; and the child seemed very little concerned during examination. The neighbouring lymphatic glands were not enlarged, and there was no pyrexia.

The diagnosis was, a tumour in connection with the parotid gland. The mother was anxious that something should be done to reduce the increasing disfigurement. The patient was admitted under Mr. H. S. Clogg, by whose kind permission I am able to publish the following account of the operation.

A slightly curved incision with its concavity upwards, 3 inches in length, was made from just behind the lobule of the right ear, half an inch above and almost parallel with the lower border of the mandible. On reflecting the skin, a non-adherent bluish mass of nævoid appearance was exposed, though separable only with difficulty from the deeper structures. The external carotid artery was seen entering the lower part of the tumour; and only after clamping it and securing numerous bleeding points was hæmostasis obtained. The whole of the parotid gland appeared to be involved, and part of the retro-mandibular portion had to be left owing to its proximity to the large vessels. Stenson's duct and branches of the facial nerve were unavoidably divided. The incision healed by first intention; the child made good progress, though when discharged the affected side was still slightly larger than the left, and the facial paralysis produced at the operation was still present. The nævoid condition of the skin which was noticed on admission had disappeared. Whether the origin of the angeioma is to be associated with the incipient function of the gland, it is impossible to determine.

In the case of the parotid the ptyalogenous function is present in the new-born child; in that of the submaxillary, ptyalin secretion is not established under the age of two months.[1] The mucinogenous function of the latter gland is probably later.

Since the observations cited by Halliburton, further investigations have been carried out in the same direction, with the following additional results: (1) The secretion of ptyalin before term. Moll[2] obtained saliva containing ptyalin from a parotid fistula in

a child prematurely born at 7 months. (2) The increased output of ptyalin after starch feeding. Finzi[3] found the amylolytic power was the same up to the age of six months, whether the food contained starch or not; after six months the power was increased if the food contained starch; the property was, moreover, highest at midday.

The following results have been recently obtained by myself at the Evelina Hospital, London. The saliva was collected by giving infants plugs of gauze (weighing 500 mgrms.) to suck, the amount of the saliva being estimated by the increase in weight of the plugs. The latter were extracted with distilled water, and the action of the fluid tested on starch solution. Ptyalin was found present shortly after birth in the saliva of infants prematurely born at 32, 34, and 36 weeks. The quantity of the ferment was very small; but it gradually increased during the first year; after this no appreciable change was demonstrable. In the premature infant of 34 weeks, 1 part of the ptyalin extract took 98 minutes to reduce an equal part of 1 per cent starch solution to the achromic point; whereas at full term (40 weeks) it took only 23 minutes; three months after birth, 11 minutes; and eight months after birth, 1 minute. The action was more pronounced in strong infants than in weak. After the age of 4 months the saliva of children who had received starch in their diet contained more ptyalin than that of those who were having none.

PATHOLOGICAL NOTE AND REMARKS BY PROFESSOR S. G. SHATTOCK.

Figure 346.—To the eye the portion removed exhibited the familiar structure of a salivary gland, the lobules being quite discrete, and but loosely held together by connective tissue.

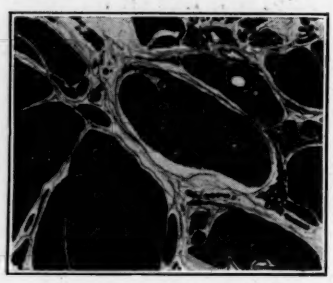

FIG. 346.—A section of the angeiomatous parotid gland described, enlarged about six times, showing the persistence of its normal lobulated construction.

Figure 347.—A microscopic study yields the following results: With few exceptions the proper glandular structure of each lobule is replaced by a close network of capillaries. In all the lobules affected, one or more patulous ducts, with their typical columnar-celled lining, are distributed in the capillary basis; in some there are, in addition, small groups of the secreting cells, these different elements being widely disparted in the vascular neoplasm; the stages from partial to complete replacement are readily traceable. Small, ill-defined groups of lymphocytes lie here and there between the capillaries; these correspond in position with the gland-ducts and cells of the alveoli. The interlobular connective tissue presents no angeiomatous abnormality. The capillaries composing the mass which replaces the lobules are so tortuous and compressed that they can scarcely be traced in detail, except by the partial persistence of the lumina, or the narrow lines of red cells within them. As studied in favourable spots the vessels, where patulous, consist of a single layer of endothelium, and they lie in apposition; where broader, the intervals contain a few connective cells, with accompanying fibrillæ.

Remarkable and little known as the condition is, it is not unique. There is in the Royal College of Surgeons, London, a circumscribed angeioma of similar kind, and in the same position, thus described in the recent Catalogue of General Pathology.[4]

A circumscribed angeioma, 5 cm. (2 in.) in chief diameter, from the parotid region of an infant. It has a definitely lobulated construction, and to the naked eye closely resembles the proper salivary gland, in the lobules of which it has arisen. Microscopic examination shows that each lobule of the gland is replaced by a plexus of capillaries with a minimum of intervening tissue. In each there are widely-scattered remnants of the proper glandular elements.

To these may be added a third example of intrasalivary angeioma, but in this instance involving the submaxillary, and not the parotid, gland. The history of this case,

which was under the care of Mr. Raymond Johnson, and operated upon by Mr. G. E. O. Williams in 1911 (to both of whom we are indebted for leave to publish it) is as follows :—

The patient, a child, age 4 months, presented a rapidly-enlarging swelling in the neck ; on examination it was found to be a fairly-well circumscribed tumour, the size of a Tangerine orange, below the left angle of the lower jaw. After excision it was thought to be a nævoid lipoma ; it was of dark-purple colour, and without a definite capsule. Many tortuous and dilated vessels were distributed through its substance. In microscopic structure I find this specimen to be a perfect replica of the two just described, the lobules of the gland being equally discrete. A few of the latter are normal ; in some, the

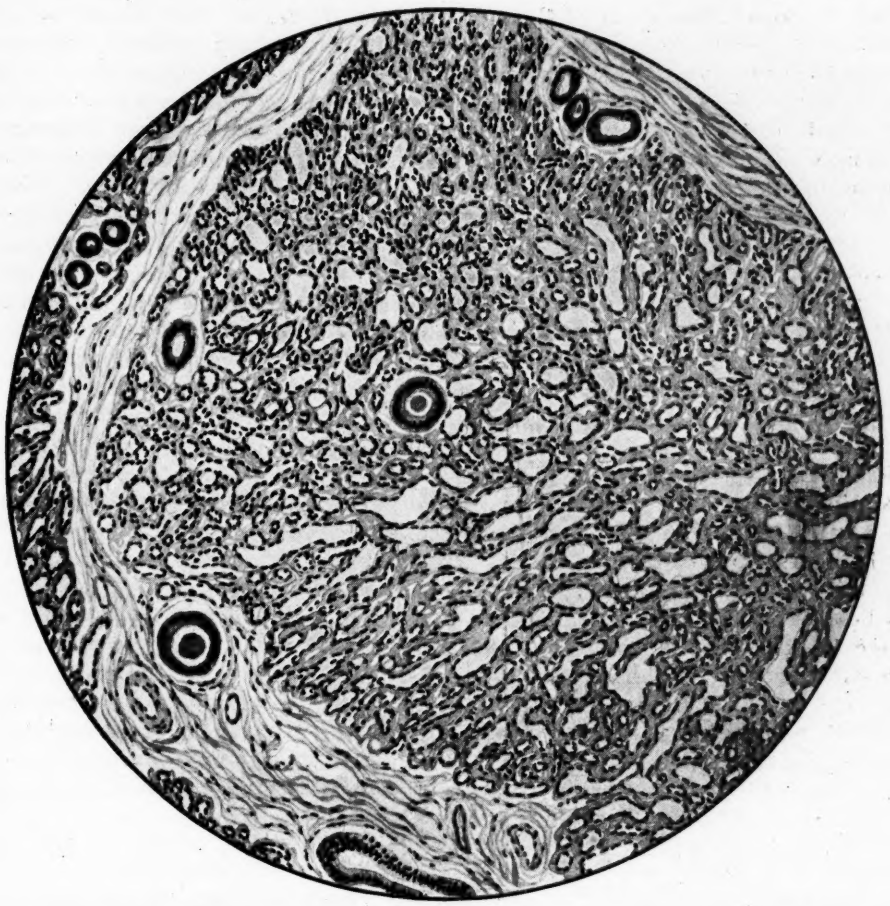

FIG. 347.—Showing a single lobule of the angeiomatous gland. It is completely pervaded with a close plexus of capillaries, in the midst of which lie some of the ducts. The septa are uninvolved in the angeiomatosis. ($\frac{2}{3}$ obj.)

angeiomatous element involves only part of a lobule ; in others, the whole, the volume of these being much augmented. The ducts and groups of secreting cells are dispersed amid the vascular plexus, as they are in the other two examples. The vessels themselves are simple capillaries with mere traces of intervening tissue. In certain spots the tortuous, thin-walled channels are abnormally wide or ectatic, though still capillary in structure. The interlobular septa are intact.

Lymphocytic foci are much less pronounced than in the first of the cases referred to.

In regard to all these examples of salivary angeiomatosis, it may be observed that the general histogenesis is of the same kind as that traceable in the development of a

capillary angeioma of the subcutaneous fat, where the lobulation and circumscription of the neoplasm may be as pronounced as is that of the lobules of the fat in which it arises. In the museum of the Royal College of Surgeons there are contained the two following specimens :—

1425.1. (*General Pathology*).—A lobulated angeioma which was removed from the shoulder of an infant. The growth is of flattened oval form, 3·8 cm. (1½ in.) in chief diameter, and is composed of a series of closely apposed but discrete lobules. Microscopic examination shows it to consist of a close network of capillaries with a minimal amount of intervening connective tissue. Scattered through the lobules there are small groups of unilocular fat-cells, the marked lobulation of the tumour being explained by its having arisen in the lobules of the subcutaneous tissue.

1426.1. (*General Pathology*).—A flattened oval angeioma, which was removed from under the skin over the breast of a child 9 months old. A small portion of the skin which was involved in the tumour and discoloured during life, has been removed with it. The growth is distinctly circumscribed, and lobulated in construction. Bristles have been put unto certain of the larger vessels which lie in the interlobular connective-tissue. Histologically, the lobules consist of a plexus of capillaries, in the midst of which fat-cells occur in varying numbers. In the case of some lobules the structure consists almost solely of adipose tissue, proving that the lobulation of the tumour is due to the origin of the angeioma in the original fat of the part.

The recognition of this origin of subcutaneous nævi in the lobules of the subcutaneous fat dates from the time of Virchow, and is concisely described in the incomparable *Krankhaften Geschwülste* (Angeioma). He observes : "The subcutaneous nævus presents most frequently the form of a tumour, and this is sufficiently well limited, though not surrounded with a special capsule. In general the aspect of this form depends on the mother tissue from which it proceeds ; and as the fatty subcutaneous tissue presents as a rule a lobulated disposition, so the nævus also takes a kind of lobulated structure."

Historically, the first example of salivary angeioma recorded in this country is that by Gascoyen.[5] The patient was a man, age 44. The tumour was congenital, and latterly had come to occupy the whole of the parotid region. There was no pulsation or bruit in the mass, which became tense and livid under excitement. Other nævi were scattered over the body and limbs. After death (which occurred from suffocation) several nævi were found studding the surface of the intestines ; one of these originated in the submucosa. The parotid tumour consisted of tortuous and dilated blood-vessels embedded in the gland, the structure of which was plainly seen filling up the intervals between their ramifications. The vessels "appeared to be the capillary veins of the gland enormously distended, which opened into large pouches, many of the dilatations being filled with phleboliths, some as large as a horse bean." Of this specimen no histological examination was made, and finer details are altogether wanting.

Two further instances are referred to by Virchow[6] as having been possibly parotid angeiomata.

One of the patients was a woman, age 29. The angeioma, which involved the parotid region, was chiefly if not solely of the arterial kind, the vessels being fed from the temporal artery. An attempted operation was followed by such hæmorrhage that no excision was carried out ; and no detailed information as to the anatomical lesion of the parotid gland is forthcoming.

The other case was a boy, age 8, who presented a swelling of the parotid and adjoining area ; the tumour projected into the mouth in the neighbourhood of Stenson's duct. It had been noticed only for a year, and from its rapid growth and uneven surface it was regarded as malignant in character. After preliminary ligation of the common carotid it became considerably paler ; during its removal the distended condition of the numerous and enlarged offsets of the carotid excited surprise. No details regarding the condition of the parotid gland are recorded.

There is at present attending St. Thomas's Hospital a further case of angeioma, implicating the right parotid region ; but as the condition is being treated by means of

radium, exact pathological details are as wanting in this as in the three last referred to. The patient was admitted under Mr. Corner in December, 1920, with a large nævoid swelling affecting the mucosa of the right cheek, extending forwards as far as the angle of the mouth, and posteriorly surrounding the orifice of Stenson's duct. The tumour, which had been slowly increasing since birth, bulged between the dental arches, and externally led to a protrusion on the right side of the face from the ear to the mouth. The suprajacent skin was uninvolved.

Two tubes of radium were inserted into the swelling—for 7½ hours on Dec. 12, and for 10 hours on Dec. 18—but with little result. Two phleboliths about the size of peas were subsequently felt in the mass, the formation of which was thought to have followed the insertion of the radium tubes.

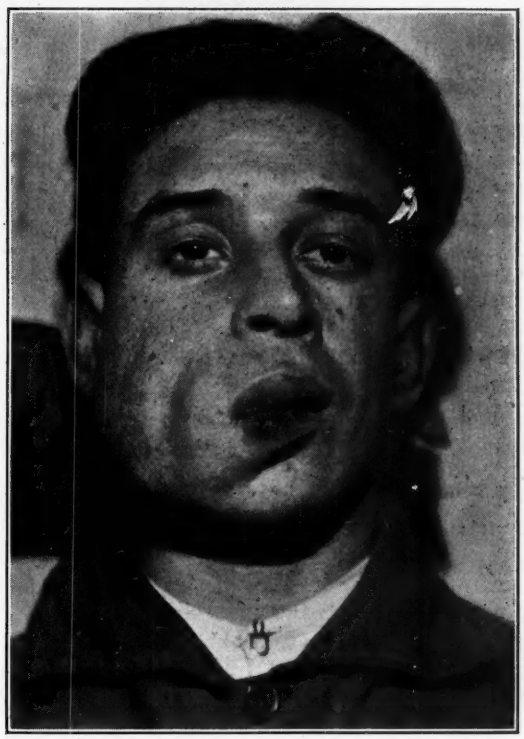

FIG. 348.—A photograph of the last case referred to, of angeioma involving the right parotid region and extending thence to the cheek and lips.

Figure 348.—On tracing the history of the case, it was discovered that the patient had previously been admitted when two years of age, under Mr. H. H. Clutton, with the note that he had been born with a nævus in the cheek, which had been increasing. At the date of admission in March, 1904, there was a large, somewhat compressible, swelling on the inside of the cheek; the diagnosis was, "Cavernous angeioma of the cheek". No operation was carried out.

The early age at which the disease was noticed in each of the three cases which were fully examined microscopically, may be finally pointed out: (1) Parotid, 6 weeks; (2) Parotid, infant; (3) Submaxillary, 4 weeks; but, as already remarked, whether the origin of the angeiomatosis is in any way related to the nascent function of the gland is a problem beyond determination. In Gascoyen's case (male, age 44) the disease was congenital. And the same is true of that at present attending St. Thomas's Hospital (male, age 18).

The gross enlargement of the veins in both of these seems to indicate that, with the lapse of time, a primary capillary angeiomatosis of the gland is succeeded by an increase in the size of the afferent and efferent vessels; a result which might be anticipated in view of the increasing demand for blood entailed by the growth of so vast a capillary plexus in the glandular substance.

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BABCOCK'S EXTRACTION OPERATION FOR VARICOSE VEINS.

By G. H. COLT, Aberdeen.

This paper deals with the late results in twenty cases of Babcock's extraction operation for varicose veins. The cases traced are from the 60 patients that I operated on in the 1st Scottish General Hospital before August, 1916, and I am indebted to the Officer Commanding for his permission to quote them.

The patients were recruits or old soldiers who had had varicose veins and in whom training had produced symptoms. Of the sixty, the oldest was 49, the youngest 18, and the median 28 years of age. The longest duration of symptoms noted was eighteen years, the shortest three weeks, and the median three years. In 11 cases there had been no symptoms, but the condition of varix had been noted on examination: in some of these there was marked tortuosity. The right side alone was affected in 5 cases, the left side alone in 12, and both in 43 cases. Operation was performed on 103 limbs ($43 \times 2 + 5 + 12 = 103$). Counting 2 ft. 3 in. as the length of vein extracted in each limb, the quantity is nearly seventy-eight yards.

Stated dogmatically, Babcock's extraction is the operation of choice for most cases, especially for the early ones in which the internal saphenous system is involved. It was introduced into this country early in 1908 by Sir H. M. W. Gray, who published papers on it in 1909[1], in which he gives a résumé of its history and the indications and contra-indications for its performance. He mentions a difficulty which is sometimes experienced in getting the knob of the instrument to pass a valve in the lower third of the thigh. This was often noted in these cases, and I find that there is generally a small tributary there communicating with the deep veins and situated four inches above the patella. The branch, as seen on the extractor, is half an inch long and comes off at right-angles to the main trunk. It is probably one of several which may unite the saphena to the deep veins in the thigh. There has been no opportunity of finding out in which direction the blood normally flows in it. When varicosity is present the blood flows *from* it and refills the internal saphena vein. It may be remembered that Thelwall Thomas in 1896,[2] after three years' trial, advised transferring the site of Trendelenburg's operation from the lower third of the thigh, which is the position originally recommended, to near the saphenous opening, and presumably the presence of this branch and of other communicating branches is responsible for the failure of simple excision of part of the internal saphena in the thigh to interrupt completely the superficial circulation there. Newbolt[3] mentioned a case in 1911 in which Trendelenburg's operation promised to be very successful, and was so for four years, but after that time the varicosities returned in greater degree than ever. The procedure, however, is of undoubted value when an impulse is present.

Sir Henry Gray[1] modified the original instrument as described by Babcock in 1907[4] by varying the size of the acorn bulbs and by putting a joint in the middle of the shaft for ease in sterilization and convenience in use when only short lengths of vein are being extracted. Babcock[5] also, in 1910, made the shaft side of the acorn cup-shaped so as to catch up the vein better and prevent its inversion and slipping over the end of the instrument. Tamisea[6] described an improvised extractor made from patella wire and the base of a cartridge with which he removed the internal or external saphena vein and tributaries at a base hospital in France. The patients were sent back to the front in from ten to fourteen days. The late results of these cases would be valuable, as apparently no additional operation on the tributaries or other veins was performed. As sold to-day

the probe portion of the instrument is of steel wire which greatly aids its passage should slight force have to be used to pass valves or extend tortuosities. The acorn tips are gauged to—

No. 1.—	No. 10	English scale	=	No. 19	French scale.
„ 2.—	„ 13½	„	„	=	„ 24	„	„
„ 3.—	„ 16	„	„	=	„ 27	„	„
„ 4.—	„ 20	„	„	=	„ 32	„	„

and of these, Nos. 2 and 4 are generally convenient. The acorns are not cup-shaped and there has been no slipping or involution of the vein in my cases. By this method, in suitable cases the whole of the internal saphena vein with about 3 inches of each of its longer tributaries can be removed and the small incisions above and below closed in twelve minutes. The removal is accomplished with less risk than by any other known method and, as the table of cases shows, with no bad result attributable to the method itself.

Apparently the first inside-out extraction was published by Keller in 1905.[7]

O'Sullivan, in April 1910,[8] was the first to publish an original inside-out extraction operation in this country. It was performed by means of a probe passed up the vein. A tourniquet was used, and the operation was done under local anæsthesia. Marmourian, in July, 1910,[9] referring to O'Sullivan's operation, mentions that inside-out avulsion had been practised at Ashton District Infirmary for two years, and in referring to the special extractor used by Babcock, quotes Murphy's opinion that Babcock's operation is " one of the simplest and most expeditious thus far devised ".

Babcock's operation is well known and only a few points learnt by experience need be mentioned.

1. The anæsthetic. A local infiltration with N.P.A. (0·25 per cent novocain) over the sites of incision is often sufficient. I saw the extraction done in two cases without any general anæsthetic and the patients said it was not very painful; nitrous oxide or so-called 'instantaneous ether' may be used for it. In general, however, when numerous other veins and adjacent tributaries have to be ligated, ligated and divided, or excised, a general anæsthetic is advisable.

2. The optimum position is the low or slight Trendelenburg, the trunk inclined head downwards, the feet slung in line with it from lithotomy crutches, and sometimes the end of the table let down. The shoulders are prevented from slipping by suitable supports. This position largely empties the limbs of blood, rendering the use of a tourniquet unnecessary, which is a help as it is much in the way of the upper incision.

3. It is convenient to get the assistant to press on the thigh just below the distal end of the divided vein in the groin while the acorn tip is being entered, so as to prevent loss of blood and show up the lumen.

4. It is important to tie and divide the saphena close to the saphenous opening so as to be certain of extracting the upper ends of the internal and external femoral cutaneous branches, sometimes called the anterior and posterior branches. Sir Robert Jones drew attention to this point during the discussion of Thelwall Thomas's paper. Clinically the posterior branch is the more important of the two. The internal saphena vein may be duplicated wholly or in part, a condition that was not met with in these cases.

5. The communicating veins in the popliteal region were, as a matter of routine, ligatured and divided, although this is not part of Babcock's original proposal. The inner one usually comes away on the extractor; the outer one from the external saphenous usually communicates with the internal saphenous system in front of the knee as well as behind the popliteal space. As a routine every main dilated channel that could be seen and marked before operation was either ligatured by underrunning, ligatured and divided, or partly excised, including the external saphena, which may require extraction. The operations on the tributaries were done at a distance from the extracted ends and preferably at a tributary junction. Some fresh enlargements have been noted in the twenty cases presented and probably occurred in veins not seen and marked. In the future it may be advisable to replace this part of the operation by Zirn's[10] intravenous sublimate injection. The ends of the tributaries, where they have been broken off by the extraction,

have sometimes been noticed during the rest of the operation to be turned sideways through about 60° and even turned completely round. The broken ends are curled in towards the lumen and the blood clotted, so that probably the rest of the vein would hold the injection. If this proceeding should prove to be efficient and devoid of risk it would save a good deal of time.

Partial extraction was alone possible in 7 limbs—in 2 to the upper third of the leg, in 5 to the middle of the leg. In the remaining 96 the attempt removed the whole length of vein from just above the malleolus to the saphenous opening. When the extractor will not pass from above downwards it may usually be passed from below upwards, and sometimes half and half. The amount of bruising seems to be less when the extraction is made upwards instead of downwards, probably because the tributaries break without being displaced through an angle before they rupture. My experience differs from that given in *Medical Science Abstracts*[11] in that the main vein does not break during extraction. It is apt to be ruptured during the insertion of the instrument if the vein is tortuous and thin, but the substitution of Babcock's method for inside-out avulsion has abolished the accident of breaking the vein during the actual extraction.

As to the kind of case in which operation is indicated there may be a difference of opinion. It is extremely difficult to form any conclusion from tests as to the degree of thrombosis and carrying capacity of the deep veins of the limb. The question did not arise so much in this series; but in civil practice, particularly in women, these factors are of great importance. Further facts as to the means adopted to decide the question, such as Mayo's elastic-stocking test, and following up the after-history over long periods to see if the operative results are in accord with the clinical decisions, are necessary.

A plethysmographic method, provided it could be arranged so as not to constrict the veins, might help us. For instance, the systolic blood-pressure and the blood-volume of the limb would be taken in the horizontal and in the erect postures. Then the rate of emptying would be noted when the patient lies horizontal and the limb is elevated to 45 degrees. The patient would stand up until the normal blood-volume was attained, and the previous observation would be repeated, but with an artificial constriction of the superficial veins above the knee. By subtraction we should obtain a value for the rate of emptying due to the deep veins. The rates of filling of the limb in the erect posture would then be recorded with the superficial veins free and also when constricted. By subtraction we should obtain a relative value of their effect in damming back the blood. These numbers would be indexed with respect to the blood-pressures and compared with the operative results five years later. The problem would be a good one for investigation by one of the new 'units'.

In the meantime, judging from the experience of the hydrostatic method of applying Unna's paste bandage in out-patient departments, the best test will be obtained by using a semi-rigid casing, rather than an elastic one, in which one can never be certain that there is not a tight constriction at some part of the limb, or that the elasticity is of the right degree.

The symptoms and signs noted as positive in the 60 cases involving 103 limbs may be set out as follows:—

SIDE AFFECTED	IMPULSE	TORTUOSITY	SWELLING	TIREDNESS, WEIGHT AND FULLNESS	PAIN	CRAMP
Right (5)	4	3	—	2	—	4
Left (12)	5	5	3	2	4	7
Right and left (43)	24	44	24	18	20	36
Right of both ..	1	—	—	—	—	—
Left of both ..	6	4	—	1	2	—
Total limbs (103)	40	56	27	23	26	47

In 11 cases there were no symptoms, but in these operation was necessary in twenty-two limbs for varicosity and a varying degree of tortuosity. It is always well to bear in mind that the etymology of varix varicis (a dilated vein, especially in the thighs, Celsus and Cicero) is unknown, and in the future it will be necessary to have an exact record of the impulse, whether forcible, medium, or slight, and of the distance it can be seen or felt on coughing. The degree of tortuosity present will have to be recorded, and it will not be easy to secure uniformity in this respect. We may merely be able to record it as extreme, cysts present, marked, medium, or slight. The total number of cases here is too small to warrant deductions, but the greater tendency to tortuosity and impulse on the left side when both sides are affected is noticeable, as also is the association of symptoms, particularly cramp, with impulse and tortuosity. Analyzing the negative relationship of cramp with impulse and tortuosity the following figures are available :—

Cramp was noted in 47 of the 103 limbs ; impulse without cramp was present in 9 limbs ; tortuosity without cramp in 19 ; impulse and tortuosity without cramp in 7 ; cramp without impulse in 22 ; cramp without tortuosity in 1 ; and cramp without impulse or tortuosity in 2, showing that cramp, the commonest of all the symptoms, is rarely present without some degree of tortuosity and impulse. The detection of an impulse on coughing is much more common than is usually thought. When present in the groin it can frequently be felt also just above the internal malleolus. When not detected at the malleolus it can almost invariably be felt below the knee above the main tributary junction. It is the most satisfactory of the tests for incompetency of the valves.

The question arises as to what prospect can be held out by operative interference. Jeannel,[12] in an exhaustive and valuable paper, gives the prospect concisely in his *Table XV* as follows :—

		Resultats	
		Guérisons	Douteux et Echecs
a. Opérations qui ne visent que le reflux superficiel	1. Opération de Trendelenburg et ses dérivées	50	50
	2. Résection de la saphène interne dans son trajet fémoral ..	52	48
b. Opérations qui ne visent que le reflux profond	1. Résection de paquets variqueux isolés au tiers inférieur de la cuisse et à la jambe	74	26
	2. Résection de la totalité ou d'une partie des saphènes à la jambe et au tiers inférieur de la cuisse	46	54
c. Opérations qui visent à la fois le reflux superficiel et le reflux profond	1. Ligatures et résections étagées sur la cuisse et sur la jambe..	60	40
	2. Saphénectomie totale	95	5

The paper should be consulted. The cases were traced over periods of from one month to fourteen years, those of complete saphenectomy from a few months to seven years. They are the only results commonly quoted and available for comparison.

In the 60 cases operated upon the immediate result was good up to the time of returning to depôt. There was no injury done to the internal saphenous nerve by the extraction. Suppuration occurred in 4 cases ; three were slight and one multiple, the latter being operated on the day after the supply of spirit for disinfection was stopped. In no case did suppuration occur along the course of the extracted vein. Hardness and bruising along the course of the extraction was of a temporary nature, and in the later results has proved to be of no account.

Out of 20 cases traced, in 7 (*Cases* 2, 4, 8, 10, 14, 17, 18) the man was killed in action after periods of from five months to two years, the average being $14\frac{3}{7}$ months and the

TABLE OF TWENTY CASES TRACED AFTER OPERATION.

Case	Age	Duration and Nature of Symptoms	Physical Signs noted and Limbs Affected	Date and Nature of Operation	Date of Report, with Result
1	18	Six months. Pain, tiredness, no cramp	Varix, with impulse to ankle. Left	Jan. 1915. Complete Babcock	Nov. 1920. Pain, swelling, tiredness both legs. A few enlarged veins left side. Four years abroad as private, and once wounded
2	19	Three years. Cramp	Varix, with impulse to ankle. Right and left	Feb. 1915. Double Babcock to upper third of leg. Local ligations with division	Killed in action July, 1915
3	27	Three years. Tiredness, swelling, 'sciatica', and cramp	Varix, with impulse to ankle. Right and left	Feb, 1915. Double complete Babcock. Local ligations with division	Nov. 1915. Very good result. Wrote when wounded. Sept. 1919, no reply
4	33	No symptoms; but rejected	Varix, with impulse to ankle. Right. No impulse left	Feb. 1915. Double complete Babcock	Sept, 1919. "The operation was successful, but the man was killed in action, Sept. 1915"
5	21	Two years. Cramp	Varix, with tortuosity. Right	March, 1915. Babcock to upper third. Local excisions. May, 1915, further excisions	Nov. 1920. Seen. Did forest work until 1917, then in line until armistice. No tiredness, no swelling; but if sits cross-legged gets cramp. Never the degree of cramp previously experienced. Scars supple. A few small veins show on inner side leg. No hardness along extraction line
6	40	Three months. Swelling, tiredness, severe cramp	Varix, with impulse to ankle. Left	April, 1915. Complete Babcock. Local ligations with division	Sept. 1919. "Never troubled since." Nov. 1920. No swelling, no tiredness, slight pain and cramp. Six months' home service, since then working as tube-work labourer
7	27	Four months. Tiredness, cramp	Extensive varix, with impulse in thigh, not leg. Right and left	April, 1915. Double complete Babcock. Local excisions. May, 1915. Excision enlarged tributary inner left appearing since first operation	Sept. 1919. "Three periods active service, thrice wounded. Went through all kinds of marches, and my legs have been all right." More enlarged veins have appeared on both sides
8	42	Twelve years. Stiffness and tiredness; worse lately after marching	Varix, with impulse to ankle. Left	April, 1915. Complete Babcock	Killed in action Oct. 1916
9	33	Three weeks. Swelling, pain in ankles, flat-foot	Varix, with impulse to ankles. Right and left	April, 1915. Double complete Babcock	Sept. 1919. "In perfect health." Nov. 1920. No pain, no cramp, no tiredness, no more enlarged veins, scars sound, 3 years' home service. "I have neurasthenia, and only do light work."
10	30	——. Weakness, tiredness, throbbing and cramps	Varix, with tortuosity, left, not right. Impulse to ankle, right and left	April, 1915. Double complete Babcock	Had no further symptoms, and was killed in action 2 years after operation
11	28	Eight years right, 1 year left. Pain, swelling	Varix, with marked tortuosity, chiefly right. Impulse	May, 1915. Double complete Babcock and local excisions	One year later right was better than left. Nov. 1920. "The veins not removed have developed greatly, and new ones have

10	30	——. Weakness, tiredness, throbbing and cramps	Varix, with tortuosity, left, not right. Impulse to ankle, right and left	April, 1915. Double complete Babcock	Had no further symptoms, and was killed in action 2 years after operation
11	28	Eight years right, 1 year left. Pain, swelling	Varix, with marked tortuosity, chiefly right. Impulse left, not right	May, 1915. Double complete Babcock and local excisions	One year later right was better than left. Nov. 1920. "The veins not removed have developed greatly, and new ones have appeared." Overseas service 3 years and 8 months as signaller in line. Has cramps right and left, and symptoms of a neuroma in one scar
12	28	Six weeks. Pain, swelling, and cramp	Varix, with some tortuosity. Left side the worse. Impulse left, not right	May, 1915, Double complete Babcock and local excisions	Sept. 1919. Two periods of active service, and twice wounded, No symptoms since operation, and can walk well.
13	45	Nine months. Pain, swelling, tiredness and cramps, especially left thigh	Varix, right and left; left the worse	June, 1915. Double complete Babcock and local excisions	Sept. 1919. "Terrible for cramps, and left leg swells at times." Nov, 1920. Is doing heavy work as mason's labourer and says he is quite well.
14	36	Fifteen years. Swelling, pains in the joints and cramps, left side the worse	Varix, with impulse to ankle, left. No impulse right	Oct. 1915. Double complete Babcock and left local excisions	Killed in action April, 1917
15	26	Three months. Tiredness, swelling, cramps, left side the worse	Varix, with impulse to ankle, left. No impulse right	Oct. 1915. Double complete Babcock and local excisions	Nov. 1920, Seen. Home defence until Sept. 1916, then 8 months at front, wounded, and 1 year in hospital. No swelling, no enlarged veins, scars sound, no cramps, able to walk well
16	30	Eight years. Cramp	Varix, with impulse in thigh, right, with big impulse to ankle left, and great tortuosity with cysts	Oct. 1915. Double complete Babcock, with local excisions left side with flaps which sloughed and required grafting	Nov. 1920, The man has pain, cramp, and more enlarged veins. He is dissatisfied with the result, but did 3 years' home service and farm servant since then.
17	34	No symptoms	Extensive varix, with tortuosity, but no impulse. Right and left	Jan. 1916. Double complete Babcock and extensive local ligations with division	Killed in action Aug. 1916. Prior to that no symptoms
18	30	Three years. Swelling, tiredness, cramp, worse latterly	Varix, right and left	Jan. 1916. Double complete Babcock and local excisions	Killed in action Oct. 1917
19	26	One-and-a-half years. Cramp in leg and foot. Three times rejected	Varix, with impulse left	Feb, 1916. Left complete Babcock and local excisions, including veins on foot	Nov. 1920. Seen. "I was able to do longer marches than I ever could have done without operation." No pain, no swelling, no tiredness, no cramp, no enlarged veins, scars supple, no hardness along extraction track. Was 273 days in France, and twice wounded. Now doing gardening work
20	33	Fifteen years. No symptoms	Varix, with marked thickening and tortuosity left, right neither thick nor tortuous. Impulse not recorded	? date, but before Aug. 1916. Right complete Babcock. Left numerous excisions	Sept. 1919. "Condition satisfactory." Two periods of active service

median 18 months. It is difficult to imagine a man being able to stand the strenuous training and severe conditions of active service prevailing at that time if the result had been other than good. These cases represent 13 limbs, showing 6 with impulse as far as the ankle, 2 with tortuosity, and 1 with impulse as far as the ankle and tortuosity. In two of these cases (4 limbs) there had been no symptoms prior to operation, and in each there is evidence that the operation had been harmless (7 months).

Of the 11 men who returned, the result may be called excellent in 6, viz.: *Case* 5 (5 years 8 months); *Case* 6 (5 years 7 months); *Case* 9 (5 years 7 months); *Case* 12 (4 years 4 months); *Case* 15 (5 years 1 month); *Case* 19 (4 years 9 months). These cases represent 9 limbs, 5 showing impulse as far as the ankle and 3 tortuosity. The result may be called good in 3 (*Cases* 3, 7, and 20), mediocre in 2 (*Cases* 1 and 13), and bad in 2 (*Cases* 11 and 16), in which symptoms had existed for eight years prior to operation. If it is allowable to add the 'killed in action' cases to the 'excellent' and the 'good', the percentage of good results is 80. This is ten per cent less than Balfour[13] reports for Mayo's[14] (with partial Schede) operation, but his results are appraised on a lower standard than mine.

It is clearly important to operate as soon as possible after symptoms appear, and in certain cases it may be advisable to operate when signs alone are present, as for instance when the patient is likely to be going to a tropical country or to be engaged in heavy labouring work or work which involves long standing. With increasing experience along the lines indicated there is no doubt that a great improvement may be expected in the results. In this connection the R.A.M.C. in peace time should, with their unrivalled means of tracing the patients over long periods and of having them examined and reported on by a medical officer, be able to furnish extremely valuable statistics in the future.

SUMMARY.

1. Babcock's extraction operation, in cases taken early, results in removing the whole of the internal saphena vein, with up to about three inches of each of its tributaries, through two small incisions, in twelve minutes.

2. The extraction operation combined with local excision of all the tributary junctions of the external and internal saphenous systems, and the extraction or excision of the external saphena vein, should be regarded as the operation of choice in ordinary cases if the symptoms are to be relieved for long periods.

3. No bad results are directly attributable to the extraction part of the combined operation.

4. Further information is required as to the frequency of occurrence of duplication or partial duplication of the internal saphena vein.

5. An investigation by a plethysmographic method of the relationship between symptoms and the carrying capacity and retarding effects of the superficial and deep veins is called for.

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A STUDY OF LOOSE BODIES COMPOSED OF CARTILAGE OR OF CARTILAGE AND BONE OCCURRING IN JOINTS. WITH SPECIAL REFERENCE TO THEIR PATHOLOGY AND ETIOLOGY.*

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I.—INTRODUCTORY.

The subject of loose bodies in joints is not only of considerable practical importance, but in addition it constitutes a pathological problem of very great interest, the solution of which has taxed the ingenuity of surgeons and pathologists from the time of Ambroise Paré until the present day. It is scarcely surprising therefore that the literature upon the subject is great, and the nomenclature diverse. Unfortunately, the subject of loose bodies in joints, like that of internal derangement of the knee, in spite of the progress that has been made in recent years, is still surrounded by a cloud of mystery and imagination which not infrequently brings discredit upon our profession, and under cover of which the charlatan and 'bone-setter' pursue their dangerous and unscientific methods. This cloud can only be dissipated by knowledge of underlying pathological principles.

The present article does not discuss the group of loose bodies comprising those formed of unorganized fibrin, fibrous tissue, fat, etc.; but confines itself to those bodies formed of cartilage, or of cartilage and bone combined, occurring in joints. Foreign bodies in joints also form a class by themselves and do not come within the scope of this paper.

Historical Summary.—We find the first reference in surgical literature to loose bodies in the works of Ambroise Paré. This great French surgeon in the year 1558 successfully removed a loose body or 'stone' from the knee. We read that the 'stone' was of the size of an almond, very white, hard, and polished. Paré was much influenced by the superstitions of his age, and includes loose bodies in his chapter on monstrosities. This does not prevent our doing homage to this great surgeon, who was the first to possess the surgical courage and skill to remove a loose body from a joint.

Alexander Monro, in 1738, was the first to recognize that loose bodies might be derived from the articular ends of the bones.

The great John Hunter considered that these bodies arose from blood extravasated after injury into the joint. He wrote: "This blood when it is extravasated into a cavity is not absorbed, nor loses its living principle, but becomes vascular and afterwards membranous, cartilaginous, or bony according to circumstances". A Hunterian specimen demonstrates another of the views of John Hunter upon the causation of loose bodies in joints which is often overlooked. It is referred to by Hunter as follows: "In 1759 I stripped the bones of an old woman that died in St. George's Hospital, and in taking off the flesh about the knee, and cutting into the capsule, there came out a stone or bone about the size of a flattened nut. On turning down the patella, I saw that the cartilage was almost eroded off it in parallel grooves, and upon the upper edge of the patella there was an exostosis—this was partly divided into two, and both seemed to have been broken off the patella and closely united by a ligamentous substance". And he ends his description of this case by saying: "These explain those cases in surgery where we find a movable cartilage or bone in the joint of the knee".

A great impetus was given to the investigation of the problem by the discovery, by Kölliker, of cartilage cells in the normal villi of the synovial membrane, and by the

* Embodying the Hunterian Lecture delivered at the Royal College of Surgeons of England.

observations of Rainey, and their theory that these cells might under certain conditions proliferate and form loose bodies in a joint. The theory that loose bodies might be derived from the articular surface fell temporarily into disfavour.

However, in many cases the body so resembled a portion of the articular surface that its origin from the latter could not be denied, and, to account for their source therefrom, Sir James Paget brought forward the theory that they were detached by 'quiet necrosis'. He says: "How can such pieces of articular cartilage be detached from living bone? They cannot be chipped off—no force can do this . . . these bodies are sequestra exfoliated after necrosis of injured portions of cartilage without acute inflammation". König, although he does not deny the traumatic origin in certain cases, considered the majority were detached by a spontaneous dissecting osteochondritis, which, without any injury to the joint, leads to detachment of pieces of the articular surface; although he admits that in the cases he examined microscopically all traces of the morbid process had disappeared! Unfortunately, many of his would-be supporters, particularly in America, cannot have read his original article; for they substitute for 'dissecans', or dissecting, the word *desiccans*, and one author has brought his facts into line with the error in nomenclature by finding that the loose bodies he described were 'desiccated'.

II.—PATHOLOGY AND SYMPTOMATOLOGY.

The loose bodies of cartilage, or of cartilage and bone, under consideration, may be classified into three groups.

GROUP I.—Loose bodies occurring in connection with some more or less general pathological process affecting the joint, such as: (*A*) *Osteo-arthritis*; (*B*) *Tabes*; (*C*) *Tuberculous disease accompanied by necrotic caries*; (*D*) *Acute arthritis due to infection.*

GROUP II.—Loose bodies occurring in joints that are otherwise apparently normal: (*A*) *Bodies having the microscopic, and frequently the macroscopic, appearances of detached portions of the articular surfaces*; (*B*) *Bodies derived from inter-articular fibrocartilages*; (*C*) *Bodies formed from detached epiphyses not forming portions of an articulating area.*

GROUP III.—Synovial chondromata, laminated and non-laminated: (*A*) *Single*; (*B*) *Multiple*; (*C*) *Diffuse.*

GROUP I.

LOOSE BODIES OCCURRING WITH SOME GENERAL PATHOLOGICAL PROCESS AFFECTING THE JOINT.

A.—LOOSE BODIES OCCURRING IN OSTEO-ARTHRITIS.

(1) *Synovial chondromata*; (2) *Detached osteophytes*; (3) *Detached epi-articular ecchondroses.*

1. Synovial Chondromata in Osteo-arthritis.—

These will be dealt with below under *Group III*, as they present the same naked-eye and microscopic appearances as the synovial chondromata that occur unassociated with osteo-arthritis. They cannot be said therefore to be the typical osteo-arthritic loose body, which distinction belongs to the detached osteophyte to be dealt with below.

Fig. 349 (Spec. 712, St. Bart.'s Hosp.) depicts pedunculated synovial chondromata occurring in an elbow-joint affected with osteo-arthritis.

2. Loose Bodies formed by Detached Osteophytes.—

As we have already seen, it is to John Hunter that we owe the first description of this mode of origin of loose bodies. Bodies of this category have certain definite features which differentiate them from the other varieties, and by which they may be at times readily recognized. Before describing these, however, it is necessary to recall briefly how an osteophyte is formed. If we examine a cartilage-clad articular surface showing commencing osteo-arthritic changes, we find that those parts of the articular cartilage most exposed to pressure are undergoing fibrillation, whereas at the periphery of the articular area the

edge of the articular cartilage is lipped, forming peri-articular ecchondroses (Shattock). Before long the deeper part of the ecchondroses becomes bony, and the ossification spreads until a nodular peripheral chondro-osteophyte is formed, covered by a layer of cartilage. This cartilage may proliferate, and ossification may continue simultaneously until large masses are formed.

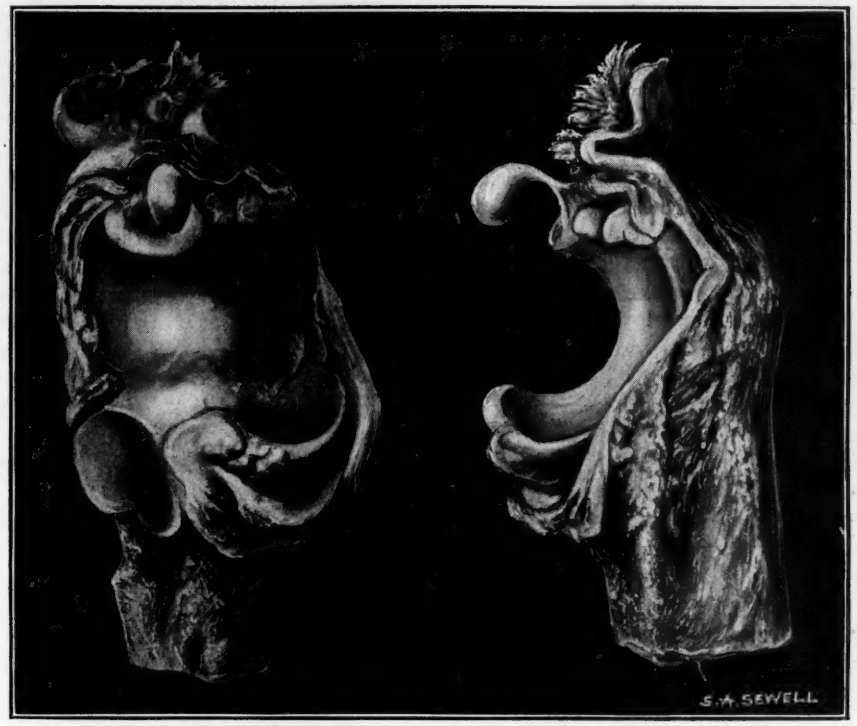


FIG. 349.—Synovial chondromata in osteo-arthritic elbow-joint.

These chondro-osteophytic formations are peculiarly exposed to injury in certain situations, and it is not surprising therefore that they may become detached, either completely or incompletely, and in the latter case are often found attached by pedicles of varied thickness to the joint margins.

When completely detached, the fractured surface of the chondro-osteophyte may be recognized, but later this may become covered by outgrowth from the surrounding cartilage.

Fig. 350 is an excellent example of a detached osteophyte forming a loose body which was removed by Sir Charles Gordon Watson, to whom I am indebted for the specimen. The narrower portion uppermost in the drawing represents the base of the osteophyte. The line of detachment may be recognized by the narrow area of bone, the cancellous tissue of which has been subsequently closed in. The body lay in the inner part of the joint cavity; it was attached by a delicate secondary adhesion to the synovial membrane, and the area from whence it was derived could be seen upon the inner margin of the internal femoral condyle. The patient from whom the body was derived was kicked upon the knee when playing football

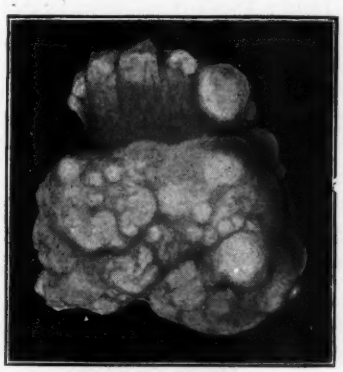


FIG. 350.—Detached osteophyte. (× 2.)

six years previously. He was confined to his bed for a week with acute traumatic synovitis. Since that date he has had several attacks of pain and swelling after undue exertion, and two years ago first noticed a loose body on the inner side of the joint. More recently the joint has temporarily 'locked' on several occasions.

FIG. 351.—Detached osteophyte. (× 2.)

In *Fig.* 351 is shown in section a somewhat pyriform osteophyte from another case. The more pointed extremity depicted on the left of the drawing is less thickly covered with cartilage than elsewhere, and may be regarded as the spot where the osteophyte was attached to the parent bone, the fractured surfaces having become covered with cartilage of new formation.

Microscopical examination of this chondro-osteophyte (*Fig.* 352) shows features of great interest, which clearly differentiate this variety from the two other types to be described later, with which it is liable to be confused, i.e., the synovial chondroma and the 'classical' type of loose body derived from the articular surface. A section through the entire body shows that the periphery consists of well-developed *fibrocartilage* with comparatively few, but uniformly distributed, cells. The latter differ from those of connective tissue in that the nuclei are spherical, although they are as yet unsurrounded with capsules. This fibrocartilage is invested with a zone of fibrous tissue furnished with flattened cells as in a perichondrium. In this fibrocartilage occur areas of hyaline cartilage. The bone in the centre consists of well-developed cancellous tissue, but is quite dead. The lacunæ are empty, and devoid of any stained elements. The contents of the spaces are mostly groups of fat-cells, but there are no stained nuclei either in the fat-cells or other tissues. At the junction of the osseous centre and the surrounding cartilage there is, in places, a zone of calcified cartilage between the fibrocartilage and the proper dead cancellous bone, *the cartilage cells in this zone being alive* but the bone-corpuscles dead. The overlying cartilage has nowhere the characters of normal articular cartilage, and there are no proper elongated or other groups at the free aspect.

To sum up: A detached osteophyte forming a loose body in a joint has definite naked-eye and microscopic appearances by which it may be recognized. It is very unusual for more than two or three of these bodies to be found in the same joint, and there is often only one of this variety present. In the same joint, however, there may co-exist cartilaginous loose bodies derived from synovial fringes.

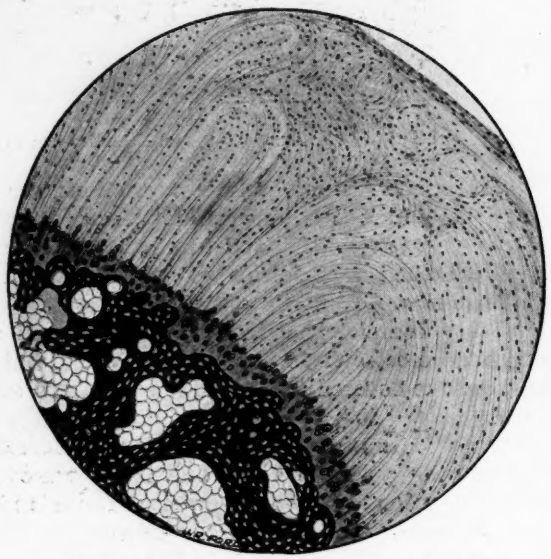


FIG. 352.—Microscopical section of periphery of osteophyte shown above.

3. Detached Epi-articular Ecchondroses.—

Professor Shattock was the first to point out that bodies of the same essential nature as the peri-articular ecchondroses growing from the articular margins might arise in the substance of the cartilage covering the normal bone. This takes place by local hyperplasia of the cartilage, in which central ossification subsequently occurs (*Path. Trans.* xl). (Spec. D97, St. Thomas's Hosp.). *Fig.* 353 is a knee-joint showing advanced osteo-arthritic

changes. The articular surfaces of the patella and femur are raised in many rounded eminences of varying size. A section carried through the patella discloses the normal contour of the subjacent bone, and an intervening zone of articular cartilage between this and the endogenous chondro-osteophytes. The epi-articular ecchondroses in this and other cases are associated with the ordinary marginal outgrowths.

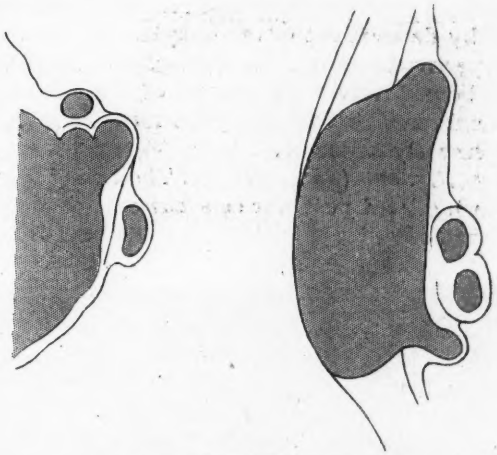


FIG. 353.—Epi-articular ecchondroses.

These observations (as Professor Shattock observes) suggest that in certain cases the separation of such might lead to the production of loose bodies of a kind similar to those which are at times detached from the articular margins. For among the nodular projections over the border of the femoral trochlea, some, which a vertical section shows to overlie the original cartilage, admit of a limited degree of movement.

In the museum of St. Thomas's Hospital there are the lower ends of two femora (from the same individual), embedded in the inner condyle of each of which there lies an almost completely detached ' loose body' (*Fig.* 354). Each of the bodies is of a regularly

FIG. 354.—Inner condyle of femur showing an almost detached ecchondrosis lying in articular area.

oval shape; its thickness considerably exceeds that of the normal articular cartilage, and it is calcified or ossified almost throughout; the pit in which it rests is, like the under surface of the loosened body, invested with fibrocartilage. "If we conceive a localized hyperplasia in the substance of the articular cartilage, a central calcification or ossification of the new formation, and a differentiation, by fibrous metaplasia, of such an enchondrosis from the surrounding cartilage, we should have, I think, a fairly satisfactory explanation of this curious specimen."

B.—Loose Bodies occurring in Tabes.

These resemble the bodies described in the last group, but all the processes tend to become greatly exaggerated, so that the loose bodies, whether formed from synovial fringes or by detachment of osteophytes, are as a rule larger. In tabetic joints, especially in the hypertrophic form, the osteophytes may be indeed enormous; moreover, the formation of bone involves the planes of connective tissue between the capsule and the synovial membrane, so that the joint may be surrounded eventually by bony masses, sometimes accurately articulated.

Fig. 355 (Spec. 824, St. Thomas's Hosp.) shows several of these features: (*a*) In the much dilated posterior compartment of the joint can be seen a large, smooth, and rounded loose body of synovial origin; above this the capsule is distended by two others of larger size. (*b*) From the anterior margin of the femur a large osteophyte extends upwards with a firm bony basal attachment. (*c*) Between the patella and tibia there is a pedunculated loose body formed by a partially detached osteophyte.

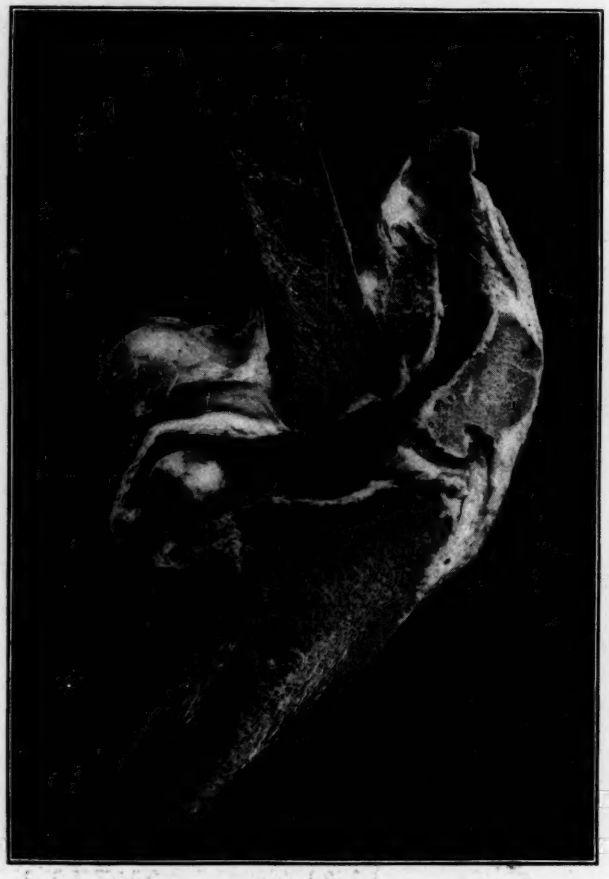


Fig. 355.—Tabetic knee-joint in vertical section.

Fig. 356.—Tuberculous sequestrum.

C.—Loose Bodies occurring in Tuberculous Disease accompanied by Necrotic Caries.

Tuberculous necrosis of considerable portions of bone is not a common condition. It affects more frequently the articular end of the femur, and is probably due to interference with the blood-supply of the affected portion, which may account for the wedge-shaped or conoidal form of these sequestra. A remarkable feature is the slowness of the process by which their separation is accomplished. A specimen in St. Bartholomew's Hospital is a good example of this condition. It shows a tuberculous sequestrum in each condyle of the lower end of the femur. Neither sequestrum is completely separated. *Fig.* 356 (Spec. 731,

St. Thomas's Hosp.) shows the upper end of the humerus with a wedge-shaped sequestrum which was lying free in the cavity of the joint, forming a loose body. The head of the bone has been almost entirely destroyed by caries, and there is a wide perforation of bone in the region of the bicipital groove. A remarkable feature is the highly-polished surface of the loose body, which is well shown in the drawing. The eburnation probably took place before the portion of bone underwent necrosis.

D.—Loose Bodies occurring in Acute Arthritis due to Infection.

These occur in the following forms: (1) Flakes of necrotic articular cartilage of variable size; (2) Bony sequestra; (3) The whole of the articular end, when the epiphysis is intracapsular, may necrose and be found quite loose in the joint.

GROUP II.

LOOSE BODIES FORMED BY DETACHMENT OF A PORTION OF THE ARTICULAR SURFACE AND OCCURRING IN OTHERWISE NORMAL JOINTS.

General Characteristics.—

1. They occur more frequently in males than in females.
2. The commonest age incidence is between the years of fifteen and twenty-five.
3. The type of loose body most frequently seen I have termed the 'classical' form. This form has the following characteristics: Shape circular or oval. Size, that of an almond. Section, plano-convex. Surfaces—The convex surface has the typical appearance of articular cartilage, whereas the flattened surface is more irregular and may be rough, lowly nodulated, or smooth, according to the degree of proliferation that has taken place. The borders are smoothly rounded (*Fig.* 357, personal specimen).

Fig. 357.
'Classical' form: both aspects.

4. Their commonest site is the knee, next in frequency the elbow. Their presence has been recorded, although rarely, in the shoulder, hip, ankle, wrist, and other joints. In the case of the knee-joint they are usually derived from the articular surface of the femur or patella, and but rarely from that of the tibia.
5. Although usually single, occasionally two or even three of these bodies may be present in a joint.
6. The bodies may be completely or incompletely detached or may acquire a secondary adhesion to the synovial membrane. When incompletely separated they are usually attached by a hinge of articular cartilage to the margin of a defect or loss of substance in the articular surface which corresponds in size and shape to the loose body. In cases where more than one body is present, these may be quite free, or one may be incompletely detached and the remainder free.
7. Cases are recorded where such a gross detachment by injury as the head of the femur or of the radius may occur and form a loose body in the joint.
8. Their continued presence in a joint may bring about secondary changes of an osteo-arthritic nature.
9. These loose bodies themselves undergo certain remarkable changes in the joint which will be dealt with in detail below.

10. The part that trauma plays in their etiology has been a subject of great controversy, and we will defer our conclusions upon that question until we have critically examined the series of cases to be next described.

11. They are occasionally bilateral and symmetrical (Bowlby, Clutton, Weichselbaum).

A.—Loose Bodies having the Appearances of Detached Portions of the Articular Surfaces.

Classification.—

I have adopted the following subdivisions: (1) Recent detachments. Bone (where present) and articular cartilage living. No proliferative changes in articular cartilage; (2) Bodies whose sojourn in the joint has been longer. The articular cartilage shows proliferative changes. The 'classical' type of loose body; (3) Marked degree of proliferation of cartilage; (4) Excessive proliferation of cartilage; (5) Feeble proliferation of cartilage; (6) Formation of new bone from the osteogenetic tissue in the cancellous spaces accompanying the formation of secondary adhesions, or incomplete detachment.

1. *Recent detachments.*—

In this series a portion of articular cartilage, with or without a layer of the subjacent bone, is detached by direct or indirect violence. The following cases are typical examples representing four different varieties: *Cases* 1 and 2, Detachment of articular cartilage and bone by direct violence. *Case* 3, Detachment of articular cartilage and bone by indirect violence. *Case* 4, Detachment of articular cartilage by direct violence. *Case* 5, Detachment of articular cartilage by indirect violence. I am indebted to Sir Charles Gordon Watson for the accompanying description of an injured elbow-joint:—

Case 1.—The head of the radius was lying completely free in the elbow-joint, and, when the joint was opened, dropped on to the operation-table. The patient, a man, age 30, fell in the street and struck his elbow against the kerb. When examined at the Metropolitan Hospital, he was found to have dislocation of both bones of the forearm backwards. This was reduced. Subsequently the joint remained painful and swollen and was *x*-rayed, when the loose body was seen. The subsequent progress of the case was uneventful.

In intracapsular fracture of the neck of the femur the femoral head may form a loose body in the joint, usually with a distinct pedicle formed by the ligamentum teres; only a few delicate bands formed from the synovial membrane.

Case 2.—(Spec. 1936A, Museum, R.C.S.). In this case the loose body was attached by a pedicle of fibrous tissue, and was derived from the articular surface of the patella in its lower part. It is a somewhat wedge-shaped piece of bone, covered on one aspect by articular cartilage. The specimen shows well the vertical structure of the cartilage, which is typical of articular cartilage when fractured at right-angles to its surface. It was presented to the museum by Sir A. Pearce Gould, to whom I am indebted for permission to publish the case. The body was removed by him from the knee-joint of a lady, age 31, who fell on her left knee with considerable force when alighting from a taxi-cab.

From notes accompanying the specimen we learn that the knee rapidly swelled, and when seen a few days afterwards the synovial cavity was apparently distended by an effusion of blood. Moderate flexion of the knee was not painful, but any attempt to extend it caused a sharp stabbing pain through the front of the joint. Lateral movements of the patella were painless, as was also movement vertically downwards; but any attempt to move the bone vertically upwards immediately caused sharp pain.

A skiagram showed that a small fragment of bone had been broken off the hinder part of the articular surface of the patella and was hinged downwards, so that what had been the highest point of the fragment was now directed backwards and impinged upon the articular surface of the femur. At the operation the knee-joint was found to be full of blood and the fragment as described above. On cutting through a few fibres by which it was adherent to the ligamentum patellæ, the piece of bone was easily removed. The cavity from which it came was easily seen and felt at the operation. The patient made an uninterrupted recovery. From an examination of the specimen, and from the history and operation findings, it is clear that this is a case of detachment by direct violence of a portion of the patellar articular surface consisting of bone and cartilage.

Case 3.—(Spec. W.O. 1777, Museum, R.C.S.). This is an excellent example of traumatic detachment of almost the whole of the articular cartilage of the external condyle

of the femur, probably by indirect violence. The specimen is from the Wharncliffe Hospital at Sheffield, and the following short history is appended :—

"While on military duty in France, the patient slipped on a stone and fell. He was unable to straighten his leg, and the knee became very swollen. When examined in England ten days later the knee presented signs and symptoms suggesting injury of the internal semilunar cartilage, effusion in the joint, pain over internal lateral ligament, and considerable limitation of movement. *X*-ray examination showed fracture of the external condyle of the femur with displacement of the fragment inwards between the joint surfaces. Three weeks after the accident the joint was opened by dividing the patella vertically, and the detached piece of bone and articular cartilage was removed. It was adherent to the condyle, but displaced inwards and forwards. The patient left the hospital eleven weeks after, walking well and able to flex his knee to a right angle".

Case 4.—*Fig.* 358 represents diagrammatically the position found at operation of a loose body now in the museum of St. Thomas's Hospital. The free aspect presented a fissure on one side. The inferior portion was extensively and finely fissured, the separation having taken place through the brittle, calcified, deep layer of the articular cartilage.

The patient was a young man, age 24, whose principal complaint was of pain in the right knee on walking. In September, 1920, after a game of football, the knee was swollen ; and the swelling and pain increased very greatly after playing again a week later. The knee was put in plaster for five weeks, but without much improvement.

X ray showed a little erosion of the anterior surface of the femur at the joint line, but no evidence of a loose body. Mr. Sargent opened the joint by splitting the patella vertically. A note by the dresser states that "examination of the joint then showed that the cartilage over the external condyle of the femur was suffering from 'Paget's quiet necrosis' ". Mr. Sargent adds that "the piece of articular cartilage was completely separated from the bone beneath, but was firmly continuous with the normal cartilage for two sides of a square, and was lying flush with the normal cartilage on all four sides" (*Fig.* 358).

When it was removed, a bare area of bone was left, about 1 in. long by $\frac{3}{4}$ in. wide, and depressed at least $\frac{1}{8}$ in. from the surrounding cartilage. The edges all round were clean cut, even where complete separation existed before operation, and there was no evidence of attempt at re-formation of cartilage.

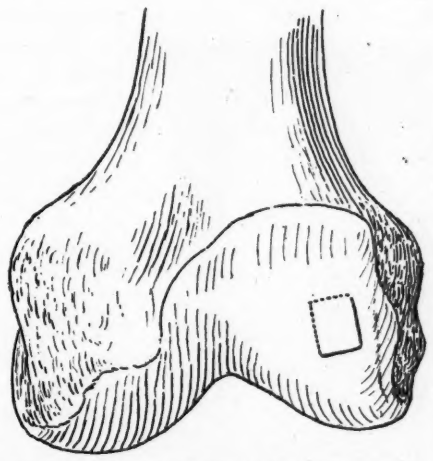


FIG. 358.—Diagram of loose body (*Case* 4) *in situ*.

The sequence of events would appear to have been that during the first game of football he received an injury to the external condyle that caused a slight separation of a portion of articular cartilage, and that during the second game the separation was increased, causing increased disability. The traumatic origin of the body is clearly demonstrated by the fissured appearance of the deep surface ; these fissures traverse the calcified zone of the articular cartilage. That it cannot be due to a process of necrosis is also clear, because it is composed of living cartilage and is not a sequestrum.

Indirect injury as a cause of a detachment of a portion of the articular surface has been so overlooked that it may be well to give the following typical example in which the loose body consisted of articular cartilage only.

Case 5.—(Spec. 826A, St. Thomas's Museum). A portion of articular cartilage, roughly quadrilateral in shape, that was removed from the knee-joint of a youth, age 17. The edges of the body are not smoothly rounded off, but on three sides are somewhat sharp and irregular as if recently fractured. On the fourth side the tissue is fibrous, the latter being evidently the ligamentous attachment.

Two days before his admission the patient felt something suddenly give way in his right knee on lifting a heavy weight. About an hour afterwards the joint became swollen, and when walking something seemed to catch so that for a moment he could not straighten his knee. There was very little pain. Next day he found there was a movable body in the joint. He was quite certain that he had received no other blow or injury. There was no history of any previous illness.

The microscopical appearances are as follows: A vertical section, excluding the smooth or free surface but including the deep, shows that the body consists of normal hyaline cartilage with rows of cells set chiefly in the vertical direction, though some are somewhat oblique. More deeply this direction is less regular, some of the groups lying almost horizontally. The cell nuclei are well stained (with hæmatoxylin) throughout.

On the deep aspect the matrix around certain of the cell groups is infiltrated with calcareous granules. Neither end of the section (which includes that of the actual specimen) shows any signs of change, but is clearly *fractured* without rounding of the edges on the deep aspect. There is no trace of bone on the deep aspect. In regard to the line of detachment, this is in places quite unaltered, but in others the line is minutely scalloped, the pits corresponding to groups of cartilage cells which have escaped. But there is no trace of cell proliferation, and no invasion of any kind with polymorphs.

The part has every appearance, therefore, of having been detached by trauma. Owing to the absence of any history of direct injury, this specimen has been until the present regarded as an example of 'quiet necrosis'. The microscope, however, has now shown that this theory of origin of the specimen is untenable, and we learn also that portions of cartilage may be avulsed by ligamentous strain reinforced by muscular action.

2. *Loose bodies in which the cartilage shows proliferative changes. The 'classical' type of loose body.*—

In this subdivision a few cases only out of the large number examined will be passed under review. Although they are all alike in showing proliferation of cartilage, they present certain minor differences.

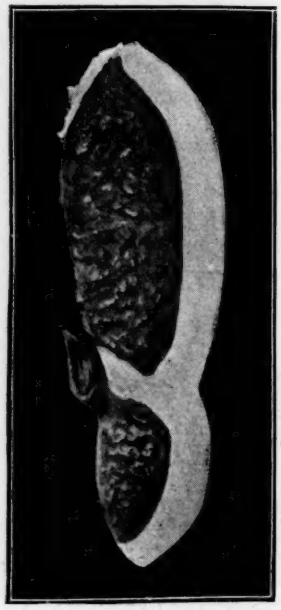


FIG. 359.
'Classical' type. (×2.) *Case* 1.

The principal naked-eye features of this subdivision have been already described. It will be sufficient merely to draw attention again to the fact that the margins of the bodies comprising this group, instead of showing signs of recent traumatic detachment, are smooth and rounded.

Many different theories have been held as to their origin: but I shall attempt to show that they are portions of the articular surface detached by trauma, and not by any pathological process, and which have continued to grow until, as we shall see later, their origin may be obscured.

In *Fig.* 357, as will be seen by reference, the loose body is a typical example of the 'classical' form. On the smooth convex surface an oblique groove is seen to be present. And a study of the section of the body (*Fig.* 359) shows that this groove corresponds to a fracture of the subjacent bone, down which has penetrated an offshoot from the deeper layer of the articular cartilage. The section also shows the articular cartilage at one end spreading over the fractured surface. I desire to lay emphasis upon the groove on the surface and upon the fracture of the subjacent bone, as it affords additional evidence of the traumatic origin of these bodies. There is a tag-like portion of fibrous tissue attached to one of the long borders. The history appended to this specimen is as follows :—

Case 1.—E. J. D., 25, came under my care in November, 1919, with the following history:—Before the war he had been a miner; he had never had any illness that he could remember, and had never had any joint trouble. In January, 1915, he joined the Royal Field Artillery, and almost immediately commenced to undergo the strenuous riding-school exercises. After a short time he noticed that his knee would occasionally become painful and swollen after riding. The pain and swelling recurred at intervals after strenuous exercise for about two and a half years. In August, 1917, his knee suddenly became fixed in the extended position as he was getting up to leave a train, and rapidly swelled. He was admitted to hospital with the knee locked in extension. He was treated for some months as a case of 'arthritis', and the limb was immobilized by splints. The treatment caused the swelling to subside, but whenever he attempted to walk the pain and swelling recurred, and the limb was immobilized once more. After a long period of immobilization the tendency for pain and swelling to occur after exercise subsided, and he was ordered a course of gymnastic exercises to remove stiffness that was present, and he was so far improved that he was able to return to duty in February, 1918, and returned to France again the following month. The

result was disastrous: the pain and swelling constantly recurred, and at length, in December, he was discharged the service permanently unfit. After discharge his symptoms continued, but in addition he became subject to attacks of severe pain in the joint which caused him to fall to the ground.

In November, 1919, he was going up some steps, when his left knee suddenly 'twisted inwards' and became locked in a semiflexed position, so that he was unable to straighten it.

When I saw him there was a considerable amount of effusion in the joint, and any attempt to extend the leg upon the thigh caused severe pain, more marked beneath the patellar ligament. At first sight this appeared to be a case of internal derangement of the knee due to injury and displacement of the internal semilunar cartilage. However, as all attempts to unlock the joint were unsuccessful, the patient was *x*-rayed and a loose body revealed. At operation I found the loose body lying in the depression of the articular surface of the external condyle of the tibia, between the external semilunar cartilage and the tibial spine. It was easy to see how its position mechanically blocked full extension of the leg. It was attached by a pedicle to the posterior crucial ligament in the region of the intercondylar notch. After division of the pedicle the loose body was removed, and the patient made an uninterrupted recovery.

From a consideration of the history it appears probable that during the riding exercises a portion of articular cartilage was gradually detached, probably by ligamentous strain or muscular spasm, and that eventually it became completely detached and caused the first locking of the joint. Afterwards the body perhaps acquired a secondary attachment to the synovial membrane over the crucial ligament, which, on stretching, gave rise to the second period of locking. Incidentally the history shows the difficulties and pitfalls that lie in the path of the clinician in these cases. The patient's condition remained undiagnosed for nearly four years; he suffered much pain and discomfort, and was eventually discharged 'permanently unfit'. An exploratory arthrotomy might have revealed the condition at once, spared him years of suffering, and supplied another soldier for the firing line.

Microscopical appearances.—A portion cut from the dried specimen after immersion in water regained its normal appearance; and microscopic sections, after staining with hæmatoxylin, displayed well-stained cartilage cells throughout, i.e., it is not a sequestrum.

Case 2.—W. G., age 20, came under Mr. Percy Sargent's care in May, 1920, with the history that nine months ago he 'ricked' his right knee whilst swimming, and experienced severe pain in the outer side of the joint, and almost immediately after noticed a freely movable body in this situation. No locking occurred, but movements were painful. Afterwards the knee was apt to give way suddenly about once a fortnight, with excruciating pain—the loose body on these occasions being felt as before at the outer side of the joint. There was never any actual locking.

On admission, the knee was slightly swollen and the synovial membrane thickened. Movements of the joint were full, and no loose body could be felt. There was some wasting of the thigh. Mr. Sargent obtained access to the joint by the vertical median division of the patella. The body lay quite loose behind the patella.

The loose body has the characteristics of the 'classical' type already mentioned. The rounded bodies are well seen, and the deep surface shows that the articular cartilage has extended from the margin of the body over the surface of the bone. This process is more advanced than in *Case* 1.

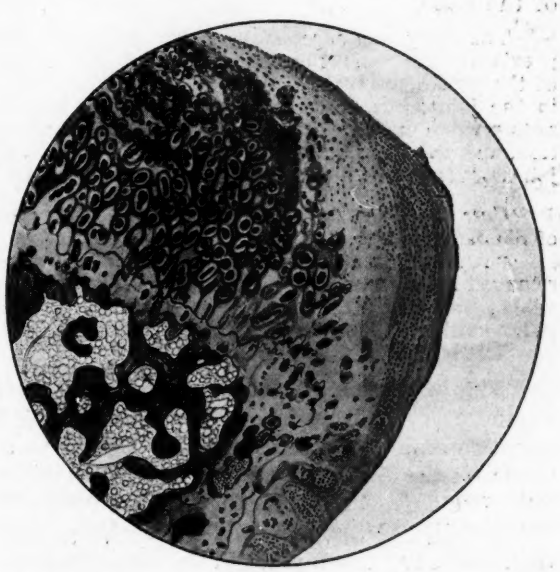


FIG. 360.—Microscopical section of free edge of *Case* 2. (⅔ *obj.*)

Microscopical appearances.—*Fig.* 360 shows the edge of the loose body (2-in. objective). From the fractured edge of the original large-celled articular cartilage a cushion of small-celled cartilage has been produced, which extends over the edge and over the under side of the fractured bone. The bone itself is necrosed,

the corpuscles in the trabeculæ ceasing to take a nuclear stain. The connective tissue within the cancellous spaces is quite dead; the forms of the fat-cells in the cancellous spaces, however, being still recognizable.

Fig. 361 represents the appearances as seen under a higher power ($\frac{2}{3}$ objective) and includes a portion of the detached surface. At the top of the specimen is seen the free surface of the reparative tissue or 'callus', which has spread from the proliferating fractured edge of the articular layer, over the opposite aspect of the fractured surface of the bone, as indicated by the fissure between the two.

FIG. 361.—Microscopical section of under surface of *Case* 2. ($\frac{2}{3}$ *obj., reduced.*)

The reparative tissue is developed well on the deep aspect, the cartilage cells being furnished with quite well-pronounced capsules. One process is shown which has intruded itself into one of the cancellous spaces laid open by the fracture. At the lower right-hand side, another elongated cancellous space is completely filled with a deeper intrusion of cartilage, the matrix of which is coloured a vivid blue; there were several adjacent spaces occupied with similar newly-formed cartilage. The lacunæ of the osseous trabeculæ are quite empty, the bone itself being dead.

Case 3.—(Spec. 1353.I, Museum R.C.S.). This loose body is biconvex, and is composed of cancellous bone covered on one side by a layer of articular cartilage. It is to be particularly noted that the articular cartilage is spreading over the fractured surfaces of the bone.

The body was successfully removed by Sir Frederic Eve in January, 1907. Five months previously the patient sprained his right knee; this accident was followed by occasional locking of the joint accompanied by swelling. When admitted under Sir Frederic Eve there was fluid in the joint, but movements were free. A loose body could not be felt, but was revealed by radiographic examination. Eight fluid ounces of straw-coloured fluid were withdrawn by aspiration, and the loose body was extracted through a longitudinal incision on the inner aspect of the joint. "It lay in a pit in the centre of one of the articular surfaces."

Case 4.—(Spec. 647, Museum, R.C.S.) This specimen is described as follows in the Catalogue of Sir James Paget, 2nd Edit., 1882:—

"A large piece of cartilage and bone of the shape and about half the average size of a patella removed from a knee-joint. It may be regarded as a portion of one of the condyles of the femur, which, probably after injury, was separated by a process similar to necrosis, but without acute inflammation. The articular cartilage is thinly extended over the edge of the bone. Presented by Sir Everard Home."

This specimen, although unfortunately there are no clinical notes attached, is of great interest from its historical associations with Sir Everard Home and Sir James Paget. The microscopical appearances are very similar to those seen in Mr. Sargent's case. The new tissue on the fractured surface is small-celled cartilage, the matrix of which in places is finely fibrillar. The groups of cells run vertically or obliquely, and at the free surface more horizontally. Near the bone the cartilage cells are larger, and in places calcification of the matrix has taken place in the immediate vicinity of what is clearly a fractured surface of cancellous tissue. At the middle of the lower free surface the cartilage over it is thin, large-celled, and the matrix is calcified.

As in Mr. Sargent's case, the cartilage has penetrated the cancellous spaces beneath it, and no stained bone-corpuscles lie in the trabeculæ around this intruding reparative

cartilage. A curious thing is that (as in Mr. Sargent's case also) the cartilage has partially penetrated into the dead tissue of the cancellous spaces, and, what is more, that isolated cells with capsule of cartilage are scattered in this necrotic soft tissue. This shows that the young cartilage cells migrate before their capsule is formed, for the only other contents of the cancellous spaces are dead connective-tissue cells and fat-cells. This remarkable migration of chondroblasts is undoubted, and sometimes cell groups with coalesced matrix occur amongst the dead contents. The trabeculæ in contact with the newly-formed penetrating cartilage are so scalloped in places that this must be due to the phagocytic action of the growing tissue. Only very rarely in the dead trabeculæ in the immediate neighbourhood of the overlying and the intruding cartilage, is a deeply-stained nucleus present in a few lacunæ, those around being empty. Such lacunæ are well formed, and there is no visible breach by which cells could have entered as extraneous. Nor are such nuclei in lacunæ near the edge of the trabeculæ, but lie fairly in the substance. It is clear, therefore, that no cell migration *through* the trabeculæ can be assumed.

Case 5.—Spec. 1936A, Museum, R.C.S.

It will have been noticed in the description of the microscopical appearances of Mr. Sargent's case that the bone-cells were all dead, and that in the Sir Everard Home specimen most were dead but a few were living. In the case now to be described a considerable number of the bone-corpuscles are living. The specimen was presented to the museum by Sir Frederick Treves; he removed it from the left knee of a labourer, age 28, who gave the following history:—

> About four years previously he fell on his left knee whilst running, and it became very swollen and painful. After this his knee occasionally swelled, and was never quite so strong as the right. Three weeks previous to admission he sprained his knee by catching his foot against the edge of the pavement, and the joint became locked for about a minute, followed by swelling. After this he could often feel a loose body in the joint, which appeared above the patella on full flexion but disappeared on extension. On examination a loose body the size of a bean could easily be felt above, to the outer side of the patella. Sir Frederick Treves opened the joint by an incision above and to the outer side, and removed the body, which was quite free; the patient made a good recovery.

The specimen is of the 'classical' type, being smooth and cartilaginous on one surface, less regular on the other, and with rounded borders.

Microscopical appearances.—The smooth free surface is composed of normal articular cartilage, with calcified zone on the deep side. Next we see the dead cancellous bone, the spaces of which hold necrotic contents. But in the trabeculæ immediately beneath the calcified zone, a considerable number of bone-cells have deeply-stained nuclei; this applies only to the innermost parts, such as the zones immediately bounding the canals. There is a thick rounded cushion of small-celled cartilage at the edges; as usual this is continued over the opposite fractured surface. In this specimen the layer of reparative tissue is thin a short way beyond the edge. The intrusion of cartilage into the cancellous spaces is in places well seen, but not so marked as in *Cases* 2 and 3.

Case 6 (Spec. 722, St. Bart.'s Hosp.).

This case is of very great interest in that the bone-corpuscles are all living and have deeply-stained nuclei. It is to be particularly noted that it is the only case in this series in which there is no history of either direct or indirect injury. We shall refer to this more fully in the next section, where we summarize the conclusions to be drawn from the pathological pictures.

The patient from whom the specimen was obtained was a bargeman, age 27, who came under the care of Mr. Luther Holden at St. Bartholomew's Hospital, with the history that he had for the last three months suffered from all the symptoms of a loose body in the left knee and could often feel it himself. He was not aware of having injured his limb. Mr. Holden removed the body by Goyraud's subcutaneous operation. It was quite free, and the patient left the hospital cured.

From the absence of any traumatic history in this case it might be inferred that the detachment was due to a process of 'quiet necrosis'.

Case 7 (Spec. in the Bland-Sutton Inst. of Pathol., Middlesex Hosp.).

Fig. 362 shows a knee-joint from a man who was run over in Oxford Street, and died soon after admission to the hospital from shock following multiple injuries.

FIG. 362.
Loose body arising from fracture of patella.

It will be seen from the illustration that there has been a transverse fracture of the patella, which, however, is not a recent one, as union has taken place between the fragments. Occupying a pouch above and to the outer side of the trochlear surface of the femur is a loose body of the 'classical' type with smooth surfaces and rounded borders. Section of the body shows on one aspect a layer of normal articular cartilage with a subjacent portion of cancellous bone; the articular cartilage from the edges has spread over and completely covered in the deep or detached aspect of the bone. Near the middle of the inner border of the patella is an area from which the articular cartilage is missing, and beneath which is an irregular formation of callus. It is highly probable that the loose body was detached from this area at the time of the patellar fracture, and that subsequent proliferative changes caused it to assume its present shape and size.

3. *Loose bodies exhibiting a marked degree of proliferation of articular cartilage.*—

Case 1.—(Spec. 721, St. Bart.'s Hosp.). This is described as follows:—

Two portions of cartilage removed from the knee-joints of a lad 18 years old. They are almost exactly alike in form and size, each resembling such a piece of cartilage as might be obtained by removing that which covers the posterior surface of one of the condyles of the femur; and each —as such a piece would be—is smooth and polished on its convex and rough on its concave surface. There was an interval of about a year between the operations by which these bodies were removed from the joints. Patient recovered completely. Presented by Luther Holden.

Unfortunately I have been unable to discover the original notes of this case, so that it is quite impossible to say whether a history of injury was recorded.

FIG. 363.—Microscopical section of *Case* 1. ($\frac{2}{3}$ *obj., reduced.*)

Microscopical appearances (*Fig.* 363).—Vertical section of whole substance shows typical articular cartilage in which the nuclei are well stained. There is no bone on the under surface —the detachment being just above or through the calcified zone. At either end there are well-marked areas of proliferated, small-celled cartilage, the free surface of which is flat-celled. The islands do not appear to have spread over the face of the fracture, for they occupy cavities in the original with excavated borders, there being no interval between the two. The matrix of the new cartilage is stained less deeply than the original.

At one end there is quite a deep inroad, the new tissue being of small-celled cartilage and connective tissue; some chondroid tissue also occurs in it (see next case). In the intruding cartilage and connective tissue there are apparently some capillaries, as if the piece was not immediately detached, or detached with some of the synovial membrane adherent.

Case 2.—(Spec. W.O. 1936F., R.C.S.). This specimen is of two loose bodies which were removed from a knee-joint. They are both oval and flattened, and the largest is 1½ in. in its greatest diameter. The body has a corrugated surface, except over an area in the middle of the upper surface, which is smooth and somewhat depressed below the surrounding level. This smooth flat area represents the original articular surface, and the hypertrophy which has taken place in connection with the fragment almost obscures its source.

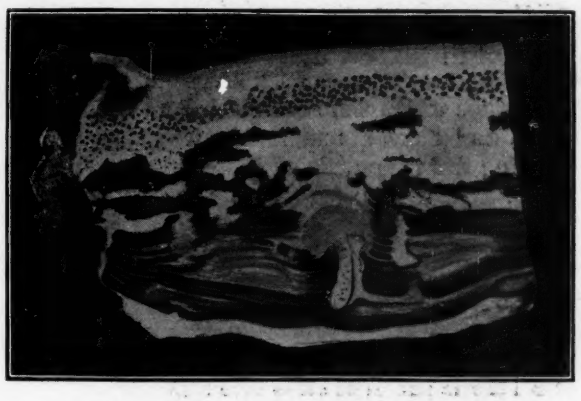


FIG. 364.—Loose body. Marked proliferative hyperplasia. (× 2.)

The bodies were removed from the knee-joint of a soldier who, while on active service, was often seized with sudden pain and locking of the joint while marching or running. The bodies could be easily felt in the suprapatellar pouch, and were successfully removed.

Microscopical appearances.—Fig. 364 shows the general appearance of the flat piece of detached articular cartilage, with the voluminous outgrowth it has furnished, which over-tops its edge and extends for a considerable thickness below. The structures of the original articular cartilage and its deeper large-celled layer are still recognizable, while beneath the latter can be seen the calcified layer. The new tissue in its general characters resembles that seen in Spec. 720B, St. Bart.'s Hosp., the tuberculated body arising in a synovial fringe to be described below. It consists of small-celled cartilage intermingled with strata of a more homogeneous material of an osteoid or chondroid character.

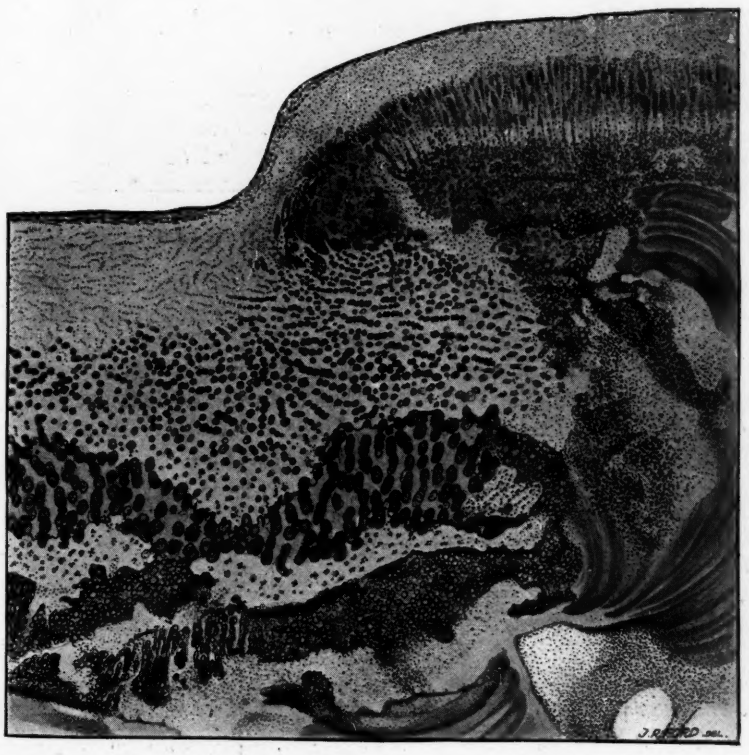


FIG. 365.—Microscopical section of left-hand upper border of preceding. (⅔ *obj., reduced.*)

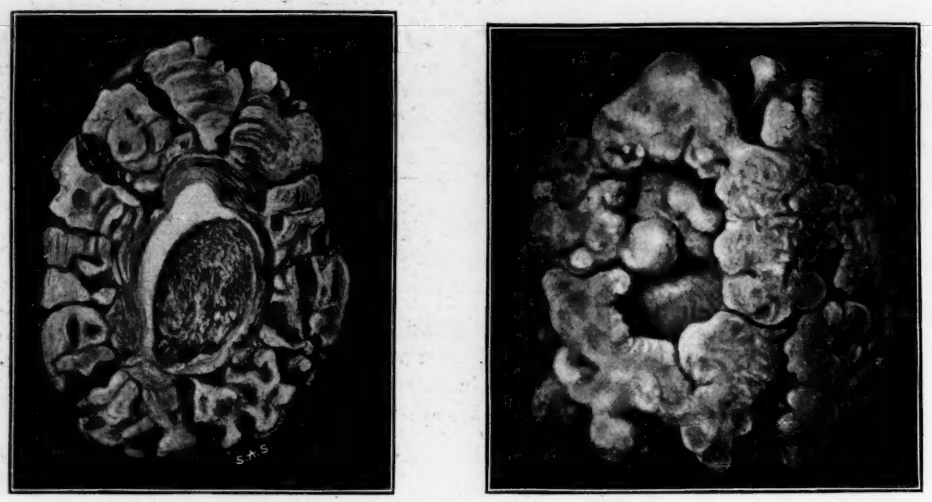
Fig. 365 shows a section of the elevation of new tissue on the right-hand side. It consists superficially of small-celled cartilage,

which bears a certain resemblance to the normal articular surface in that the more superficial cells have a flat disposition. More deeply the matrix has undergone calcification, and to the extreme right the new tissue takes the form of 'laminar osteoid tissue'. On the right-hand side, at the lowest part, is a bay filled with loose connective tissue, which is edged with a zone of proliferating cells, and in connection with which a laminar formation of osteoid tissue and cartilage has occurred.

4. *Loose bodies exhibiting a striking degree of proliferation.*—

The phenomena presented by this subdivision are truly remarkable; the cartilage cells proliferate with such exuberance that veritable cartilaginous tumours are formed. In the centre of the body can be seen the fragment of the articular surface originally detached.

Case 1.—(Spec. 1353.2, Museum, R.C.S.). Consists of two loose bodies of unusually large type which were removed from a knee-joint. They are both somewhat discoidal in form, and have a remarkably irregular, coral-like exterior, like some of the osteomata growing from the ends of the long bones; the larger has a chief diameter of 2½ in. As seen in the section (*Fig.* 366), the smaller of the two bodies has in the centre a nucleus of



FIGS. 366, 367.—Loose bodies exhibiting marked degree of hyperplasia. (*Natural size.*)

dense osseous tissue, which is covered on one aspect by a layer of cartilage having the appearance of articular cartilage. Next succeeds a thick crust of cartilage which is obviously laminated in a circumferential manner. This external crust is traversed in places by fissures which have for the most part a radial arrangement. The general arrangement of this peripheral crust of cartilage suggests that seen in the last specimen (Spec. 1936F, Museum, R.C.S., *Fig.* 364), and also the pathological variety of loose body (Spec. 720B, St. Bart.'s Hosp.). The accompanying description states:—

They were removed from the knee-joint of a labourer, age 25. The loose bodies lay in the cul-de-sac beneath the quadriceps extensors, and were very freely movable. The patient noticed a swelling in that situation after a fall on the knee five years previously. The margins of the femur were lipped, but there was no other evidence of osteo-arthritis.

Case 2 (Spec. 1931B, Museum, R.C.S., *Fig.* 367) is an equally remarkable example of very marked degree of proliferation of the articular cartilage. The short accompanying description states that:—

It was removed by operation from the knee-joint of a man, age 55, who had been unable to flex his leg to the full extent for some months. A hard movable body could be felt in the supra-patellar recess of the joint previous to operation. There were evidences of rheumatoid arthritis in the knee.

The body, which measures 2 in. in greatest diameter, is coarsely lobulated. On one of its surfaces there is a depressed area, the surface of which is comparatively smooth, and which is overlapped on either side by the surrounding lobules of cartilage. This smoother depressed area corresponds to the original surface of the detached portion of articular cartilage. A remarkable feature is that there is a fissure which traverses the newly-formed cartilage and also the included portion of cancellous bone, almost completely separating the body into two portions, the bond of union between which is a bridge formed by the original articular cartilage. We see, therefore, even in this marked example of the proliferative type, the same evidence of its traumatic origin that we have already described in previous cases.

5. *Feeble proliferation of articular cartilage.*

This is a rare condition, and is represented by but one example (*Fig.* 368) among the large number examined in the course of this research. This specimen is the one of 'quiet' necrosis described by Teale. It will be seen, as is so often the case, that the portion of the internal condyle from which the body was detached is that in the vicinity of the intercondylar notch.*

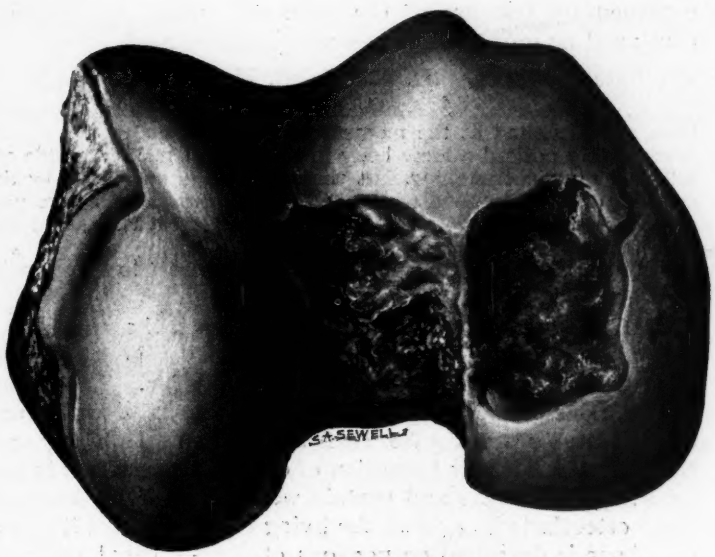
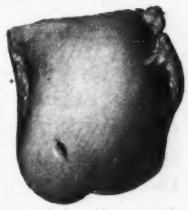


Fig. 368.—Teale's case, showing portion detached; upper border artificially removed.

Microscopical examination.—The cartilage cells towards the free surface stain feebly (possibly the result of imperfect fixation). More deeply the groups of cells and their nuclei are sharp and the nuclei fairly—not intensely—stained. On the free deep side, here and there are portions of large-celled cartilage. The remainder of the surface has the appearance of having been subjected to a good deal of friction, which has probably detached the remainder of the reparative tissue. At one spot below the large-celled deep cartilage is a small portion of bone—the articular bone.



We have already seen that when a portion of the articular surface is incompletely detached, or completely detached but remains *in situ*, its deep surface is subjected to a considerable degree of friction from the joint movements, and it is obvious in the above case that the reparative tissue has apparently been subjected to this form of attrition.

6. *Formation of new bone from the osteogenetic tissue in the cancellous spaces accompanying the formation of secondary adhesions, or incomplete detachment.*

In the cases that have been hitherto described, one very striking fact that forces itself upon the attention is that no case demonstrates new bone in process of formation. The cancellous spaces contain merely necrotic tissues, and no living and active osteogenetic cells. It will have been noted that these bodies were all quite free in the joint.

The examples of the subdivision we have now to consider were found at operation to

* I am indebted to Professor Stewart, of Leeds, for kindly lending me this specimen.

have acquired a secondary adhesion to the synovial membrane or to be incompletely detached. In this variety we find that the cancellous spaces still contain living contents and vessels, and that although many of the deeper bone-corpuscles, that is, those lying nearer to the articular cartilage, are dead, yet the more superficial cancellous spaces contain osteogenetic tissue actively engaged in laying down new bone upon the surface of the old. There can thus be little doubt that a loose body may, if attached secondarily to the synovial membrane or if incompletely detached, increase in size not only by proliferation of its cartilage cells but also by formation of new bone. Moreover it appears that, should secondary detachment of the loose body occur, the formation of bone ceases, whereas the cartilage continues its growth. This increase in bony substance of an attached loose body is important from the etiological point of view, as we shall see later, particularly in those cases where a loose body attached to a crucial ligament of the knee-joint occupies a pit on one or other femoral condyle. At first sight it would appear difficult to understand how such a body as that shown in *Fig.* 375 could be detached by traction of the ligament, unless we realize that the bone has probably continued its growth after incomplete detachment.

Case 1.—(Spec. S.D. 411, Lond. Hosp. Path. Inst.).

P. C., two months before admission to the London Hospital, sprained his knee in jumping from a ladder, and at the moment of the accident noticed a 'clicking' in the joint. He almost immediately noticed a loose body in the joint to the outer side of the patella. The accident was followed by slight swelling, but there was no pain and no locking. On admission, there was no swelling of the joint, and active and passive movements were painless. A loose body the size of a hazel-nut could be felt half an inch above the patella, and was revealed also by radiographic examination.

Mr. Lett removed the body, which was adherent to the synovial membrane of the suprapatellar pouch.

Microscopical examination.—This shows the cartilage to be normal living articular cartilage. Below the cartilage lies cancellous bone, of which the spaces are filled with normal living connective tissue and capillaries. The lacunæ of the bone, however, are empty, none of the bone-cells having survived. On the lower aspect of the bone the case is different, for here the free surface is formed by a highly vascular layer of loose connective tissue in which a new formation of osseous trabeculæ is in progress. These are surrounded by living osteoblasts and contain well-stained living bone-cells in their lacunæ; here and there osteoclasts lie against the living trabeculæ, and it can also be seen in places that the new bone is deposited on portions of dead original trabeculæ. The phenomenon is thus one of callus formation from connective tissue.

B.—Loose Bodies derived from Interarticular Fibrocartilages.

The question of injuries to the semilunar cartilages of the knee-joint is a large one, and is beyond the scope of the present article; I am, moreover, making it the subject of a further research. It will suffice to mention here that a portion of one of the semilunar cartilages—usually the anterior end of the internal semilunar—may occur as a rounded cartilaginous body, either attached by a pedicle of variable thickness to the remainder of the cartilage, or the pedicle may rupture and the body become quite free.

I have seen the internal semilunar cartilage completely detached from its site and with a secondary attachment round the periphery of the patella. Occasionally the posterior horn of one of the semilunars may form a pedunculated loose body in the joint. A good example of this is seen in Spec. 716C, St. Bart.'s Hosp. The posterior end of the internal semilunar has become hypertrophied and rounded, and made a groove for itself upon the articular surface of the external condyle.

C.—Loose Bodies formed by Detached Epiphyses not forming Portions of an Articulating Area.

(Spec. 714C, St. Bart.'s Hosp.). This loose body was removed by Sir Charles Gordon Watson from the elbow-joint of a boy, age 17, in whose joint it had been present for four years. There can be little doubt that the body is a detachment of the epiphysis of the external condyle of the humerus.

One surface of the loose body is convex and lowly nodulated, the other surface being concave. The section shows that there is a nucleus of bone in the centre, and that the convex aspect is covered by a thick layer of cartilage, which has also apparently spread over the concave detached surface. This cartilage has none of the characteristics of articular cartilage.

The history of the case is as follows :—

Four years previous to admission, when 13 years old, he fell upon the outer side of the left elbow. The accident was followed by pain, swelling, and stiffness of the elbow, and shooting pain down the radial side of the forearm. He suffered subsequently with recurrent attacks of painful locking, accompanied by swelling.

On examination at time of admission, it was found that the external condyle of the humerus was not in its natural position, being lower than normal. About one inch external to the olecranon is a hard prominent swelling, bony, and about ½ in. in diameter, and bony crepitus can be detected. This swelling is thought to be the displaced external condyle of the humerus. *Measurements:* Acromion to ext. condyle, left 12¾ in., right 12⅓ in. *Movements of elbow:* Flexion complete; some limitation of full extension. Supination incomplete and painful. Skiagram appears to show the external condyle of the humerus to be separated from the rest of the bone and displaced downwards.

Sir Charles Gordon Watson made an oblique incision over the most prominent part of the swelling, and found a loose body lying quite free in the joint cavity. It will be remembered that the centre of ossification appears in the cartilage of the external condyle at about the twelfth year and, coalescing with the centres for the trochlea and capitellum, forms with them an epiphysis which joins the shaft at about the seventeenth year.

GROUP III.

SYNOVIAL CHONDROMATA, LAMINATED AND NON-LAMINATED.

They may be divided into three classes: (*A*) ***Single***, pedunculated or free; (*B*) ***Multiple***, pedunculated, free, or the two conditions combined; and (*C*) ***Diffuse***, usually associated with free bodies in the joint cavity.

The discovery by Kölliker of cartilage cells in the villi of the synovial membrane, and the observations of Rainey, have already been referred to in Section I. The loose bodies of the important group we are about to pass under review, although they may differ in structure and form, have the common characteristic that they have originated from the cartilage cells of the synovial villi, and are, therefore, true chondromata. It is impossible in the present state of our knowledge to assign a cause for this behaviour of the cartilage cells. In many cases there is a history of injury; in others this is absent, and they often appear to occur in the course of chronic synovitis. Whether, however, the presence of the synovial chondromata caused the synovitis, or the latter was the exciting cause of the tumour formation, it is impossible in many instances to say.

A.—Synovial Chondromata. Single Variety. Pedunculated or Free.

Non-laminated.—The naked-eye characters of the single chondroma are shown in *Fig.* 369 (Spec. 1353.I, Museum, R.C.S.). It shows a lowly lobulated, oval chondroma, 3·5 cm. in chief diameter. In its centre there is a loculated cavity due to mucinoid degeneration; it contains no bone. On the front of the specimen there is a central depression filled with fibrous tissue, of which tags project from the surface, apparently its site of attachment.

Fig. 369.—Non-laminated chondroma.

It was removed from the right knee-joint of a woman, age 42, who had for a long time been unable to kneel. The tumour was excised from the synovial membrane to the inner side of the patella, and was so attached to the outer aspect of the former that the knee-joint was not opened. Although the body lay in the subsynovial tissue without projecting into the joint proper, it may be assumed that it arose in connection with a minute cartilaginous nucleus in a synovial villus.

Laminated.—Except for the fact that they occur singly, the naked-eye and microscopical features of loose bodies of this type are very similar to the multiple laminated type to be reviewed below. As a rule, however, they grow to a greater size than the multiple loose bodies, and tend to occupy pouches or recesses of the synovial membrane, where they lie snugly. Owing to this characteristic, and also to their greater size, they but rarely cause the classical symptoms to which a loose body gives rise when it becomes caught between the articular surfaces. They are often discovered accidentally or on post-mortem examination. As we have noted in connection with the multiple type, one side of the loose body (usually that in contact with the synovial membrane) may be comparatively smooth and lowly convex, and may simulate somewhat closely the type to be described below derived from a detached portion of the articular surface, more particularly that of the femur. If a section of the body is examined, however, it will show the typical laminated appearance of a synovial development (*see Fig.* 370). This is an important point, as it seems clear that several of König's cases belong to this group. A history of antecedent injury may or may not be present.

Laminated.—The superficial and also the divided surface of a loose body, ¾ in. in its chief diameter, which was successfully removed from the knee-joint, and is preserved in the Pathological Museum of St. Thomas's Hospital. On both aspects the body was lowly tuberculated. It is extremely hard from calcification, which, as seen in the divided surface, has occurred in a laminated concentric manner.

The specimen was obtained from a man, age 40, who had received an injury to the knee and was admitted with a large effusion in the joint. No fracture was discovered by skiagraphy. When the swelling had subsided, a loose body was felt in the subcrural pouch. The body had caused no symptoms at any time, and there was no history of antecedent injury. There were no signs of osteo-arthritis.

B.—Synovial Chondromata. Multiple. Pedunculated, Free, or in Combination.

Laminated.—The size, shape, surface, and general characteristics of the multiple type are well shown in Spec. 720B, St. Bart.'s Hosp. (*not figured*).

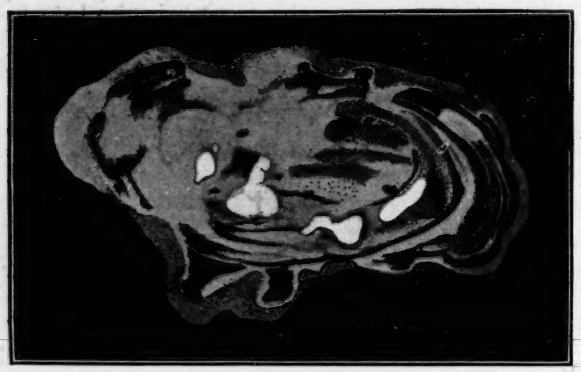


Fig. 370.—Section of laminated chondroma. (*Enlarged.*)

Fig. 371.—Abernethy's case. (*Nat. size.*)

It should be noticed that certain of these bodies are comparatively smooth on one side. This may be due to mutual pressure; but in many instances I have observed that these bodies occupy little pockets or pouches of the synovial membrane, and on lifting them from their bed it can be seen that the surface in contact with the latter is smooth, whereas the surface opposed to the joint cavity is more irregular, the result probably of the pressure exerted on the deep side. The description in the museum catalogue of this specimen is as follows:—

Thirty-five loose bodies from a knee-joint removed by operation. Four or five were in the main cavity of the joint; the remainder were lodged in a large bursal sac in the popliteal space.

Only one was attached by a long narrow pedicle; the rest were completely free. Patient was a young man, age 19 years. Six years before, the knee had been violently wrenched at football and the patient confined to his bed for a month. The bodies had been noticed in the joint for between two and three years, but the exact period of their development was uncertain. He made a good recovery from the operation, and when seen three months afterwards had free movement of the knee and was able to play tennis and to dance. Presented by H. Marsh.

There can be little doubt that these bodies originated as small pedunculated cartilaginous growths from the synovial membrane; that after a time they became detached, and that the majority of them found their way into the cyst in the popliteal space. The smallest of the bodies are seen still to have traces of their original pedicle, whereas in the larger (*Fig.* 370) no trace of a pedicle can be seen. It is clear from this that the bodies have continued to grow while quite free in the joint cavity.

Another interesting point in this case is that at operation only one cartilaginous body was seen to be attached to the synovial membrane.

Fig. 370 depicts the naked-eye appearance of a section of one of the loose bodies from Specimen 720B, and brings out well the concentric lamination which is one of their marked characteristics, and the cavities in the deeper part that have resulted from mucinoid degeneration of the cartilage; and *Fig.* 371 shows the divided surfaces of three out of fifteen loose bodies which were discovered post mortem by Abernethy in the hip-joint of an old woman. Although these are described as osteophytes, yet they are clearly of synovial origin.

Microscopical section (*Fig.* 372) shows a portion of the free surface of the same specimen as that represented enlarged four times in *Fig.* 370. The surface is covered with a fibrous membrane which is prolonged inwards as a bay, where the tissue is of more open texture. The deeper part of the fibrous tissue is very cellular, and is evidently the source of the more compact tissues produced on the deep aspect. Of the two deeper zones, that next the proliferating zone consists of a matrix coloured with the eosin, containing scattered cells without any recognizable capsules, but which may probably be regarded as immature cartilage, since a study of other sections shows that it is interchangeable and may merge into well-formed cartilage. It will be noticed that in the left-hand side of the bay referred to, an area of well-formed cartilage has been produced from the indifferent proliferating zone.

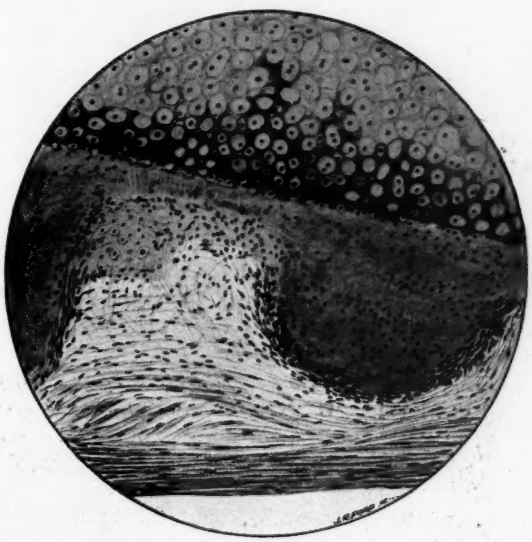


Fig. 372.—Microscopical section of portion of specimen shown in *Fig.* 370.

Above the immature zone there follows one of well-developed hyaline cartilage. Lastly, from the deepest part of the 'bay' a certain number of delicate fibres radiate with the tissues above like the proliferating fibres of bone. These in other sections are traceable in places into the matrix of the proper cartilage.

As shown by *Fig.* 370, the remainder of the body is seen to be made up of alternating zones of cartilaginoid tissue and cartilage, the latter in places having undergone calcification. The zones do not form complete circuits of mathematical accuracy. The lamination, as seen by the naked eye, is due to the areas of calcification. In the centre, mucinoid degeneration of the cartilage has taken place.

Non-laminated.—Case 1.—(Spec. 720A, St. Bart.'s Hosp., *Fig.* 373.)

Shows 415 loose cartilages removed from the right knee of a shoemaker, age 31, by Sir Thomas Smith. Most were lying quite free in the joint cavity, but a few of the bodies were attached by

slender pedicles to the inner surface of the synovial membrane. The patient stated that six years ago, without obvious cause, his knee became painful and swollen, and that the pain and swelling had steadily increased. The pain was more marked when the leg was extended.

On admission, the joint was seen to be generally enlarged and filled with small movable bodies, giving the sensation of shot in a bag.

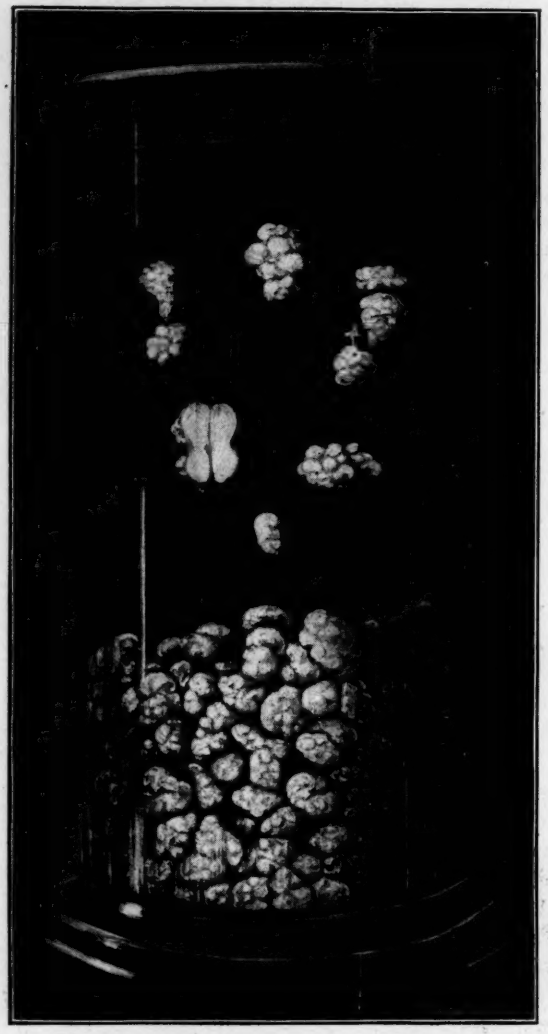


Fig. 373.—Multiple loose bodies. Spec. 720A, St. Bart's.

On examination, the smaller of these bodies are seen to consist of a single nodule of cartilage surrounded by connective tissue, and the larger consist of two or more nodules of cartilage held together by a loose network of connective tissue which also surrounds the periphery.

In the *Pathological Society's Transactions*, London, vols. xlii and xlv, Mr. James Berry has described a very interesting case which clearly belongs to the subdivision we are considering.

Case 2.—*Non-laminated.*—The patient was an otherwise healthy young man, age 18. For about six months he had been subject to pain and swelling of the right knee, which prevented him from working; about two or three weeks before admission he had noticed movable bodies in his knee. There was no history of rheumatism or other illness, nor was there any history of trauma.

Mr. Berry removed the bodies, which showed the following features. All were white in colour and with a smooth and shining surface, and none had pedicles. The larger ones consisted of a number of small nodules of cartilage held together by an intervening network of very loose connective tissue. No epithelium could be seen on the surface. The smallest bodies consisted of a single nodule of cartilage surrounded by a layer of connective tissue. He was unable to express any definite opinion as to the origin of these bodies, but considered it doubtful whether they had been formed from the synovial fringes, because all the bodies were free, and the portion of synovial membrane that was seen at the time of operation was normal. He mentions, however, that at one spot the membrane was thickened and formed a lump, and suggested that it may have been from this spot that the loose bodies were derived.

After the operation the patient remained quite well for three years, but he then began to notice weakness and occasional swelling of the knee previously operated upon. After suffering for six months he came to the hospital again, and Mr. Berry removed no less than 1047 loose cartilaginous bodies. The bodies resembled those removed at the first operation, but were smaller. The lump that was felt in the suprapatellar pouch at the first operation could no longer be detected.

C.—Synovial Chondromata. Diffuse Variety.

Spec. 720C, St. Bart.'s Hosp., is a beautiful example of this variety, removed by Mr. Harrison Cripps from the left knee of a girl, age 14 :—

Beyond measles when 4 years old she had had no previous illness, and there was no history of trauma. She first noticed pain in the left knee about two years before admission, and about one year ago she noticed some 'lumps' which appeared in various situations. At about this time also she experienced a 'clicking' sensation in the knee, which frequently gave way under her.

When admitted she was seen to be a healthy-looking girl. "The left knee looks a little swollen. A small swelling is felt just outside the patella when the leg is straight; on bending the knee to a right angle, this swelling becomes more distinct, and a second and smaller swelling is to be felt just above and inside the knee-cap. This is firmer than the former, and on straightening the knee again, it seems to slip away under the patella. Both swellings give a peculiar crunching feeling on being pressed, and there is some pain. Nothing is felt below and inside the patella, where patient states that sometimes a third swelling appears."

Mr. Cripps transfixed the loose body that was situated above and inside the patella. He then cut down upon it, thus opening the joint. A thickened synovial fringe was found, and in it were a number of cartilaginous nodules about the size of peas. Some of these nodules were lying free in the joint. One mass, about 1½ in. long and 1 in. diameter, was likewise found perfectly free. On passing the finger under the patella, Mr. Cripps found another mass of nodules lying in the outer part of the joint. A second incision was therefore made on the outer side of the patella, and the whole mass was removed. The patient made an uninterrupted recovery.

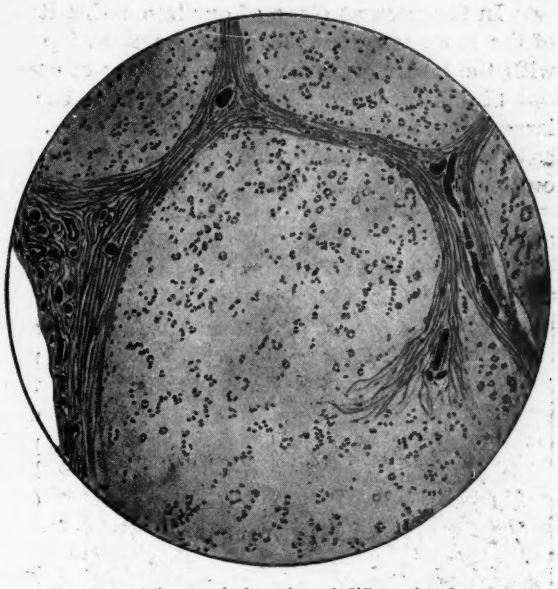


FIG. 374.—Microscopical section of diffuse chondroma. (⅔ *obj., reduced.*)

The specimen shows the mass of lobules of varying size growing from the synovial membrane. The mass in the centre is particularly prominent, and its surface is subdivided into secondary lobules. The lobules have a smooth surface and a pearly lustre. Portions of the synovial membrane can be seen at the margins of the specimen.

Fig. 374 shows the microscopic appearances. The tumour is composed of lobules of hyaline cartilage, between which are septa of fibrous tissue containing vessels. On the left is shown the fibrous capsule of the growth with its pertaining vessels.

Changes occurring in a joint from the long-continued presence of a loose body. (Spec. 1926, Museum, R.C.S.:). *Fig.* 375 shows a large loose body of traumatic type produced by indirect violence such as violent traction exercised through the anterior crucial ligament, which was attached to the anterior crucial ligament and occupied a pit in the under surface of the external condyle of the femur. The section shows quite clearly its origin from the articular surface, although, according to the museum catalogue, it was considered to be one of synovial origin that "by friction and constant pressure had worn for itself a deep cavity in the condyle of the femur".

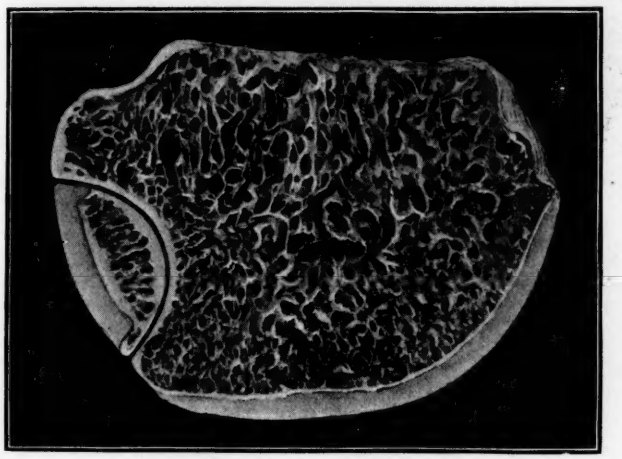


FIG. 375.—Loose body embedded in condyle.

It is to be noticed that the condyle is practically denuded of its articular cartilage and the exposed surface of the bone is eburnated. One very interesting point is that the deep surface of the loose body and the bottom of the pit are also eburnated and marked by friction grooves. Some lipping of the articular margin is also

present. This loose body has almost certainly increased in size after detachment from new bone formation.

Occasionally loose bodies characteristic of osteo-arthritis may co-exist with a traumatic loose body.

III.—ETIOLOGY AND PATHOLOGICAL DEDUCTIONS.

In the present stage of our knowledge it is impossible to dogmatize upon the etiology of the more important loose bodies of *Group I*, i.e., the osteophytes, since it is bound up with the larger question of the etiology of osteo-arthritis.

Similarly, the etiology of *Group III*, the synovial chondromata, is bound up with the larger question of the etiology of tumours. Although it is probable that the cartilage-cells in the synovial villi from which they originate are, as Professor Shattock pointed out, derived from the primitive cartilaginous bar which in the developing embryo becomes cleft to form the knee-joint, the periphery remains to become the capsule and synovial membrane. Trauma, however, undoubtedly may be a contributory factor. *Fig.* 376 shows an *x*-ray of one of my cases, where the patient was struck a severe blow just above the patella, a year previous to the *x*-ray examination. This section will therefore deal principally with the etiology of the type of loose body derived from the articular surface (*Group II, Class* 1).

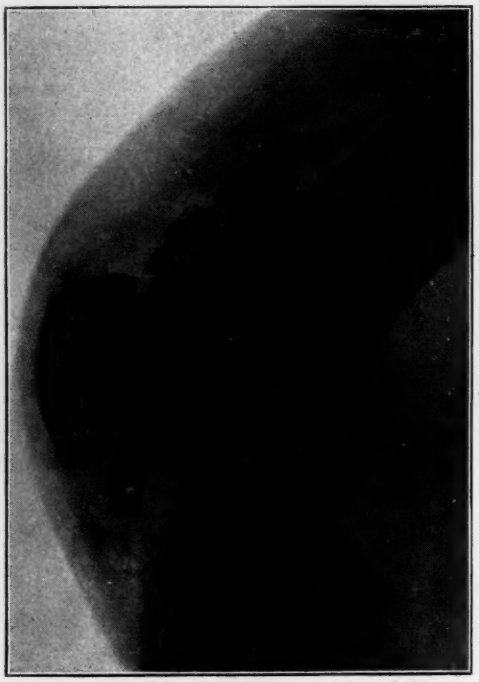


FIG. 376.—Skiagram; multiple chondromata.

1. DEDUCTIONS TO BE DRAWN UPON THE ETIOLOGY OF LOOSE BODIES OF GROUP II (CLASS 1, INCLUDING CLASSICAL TYPE), FROM THE PATHOLOGICAL AND CLINICAL DATA, WITH AN ACCOUNT OF SOME EXPERIMENTAL OBSERVATIONS.

A.—Deductions from the Pathological Data.—

1. When composed of articular cartilage only, the latter, so far from being necrosed, is perfectly healthy (except perhaps in the Teale case) and in many cases actually proliferates. Anything more unlike a sequestrum in its behaviour it would be impossible to imagine.

2. In the large series examined there were no signs of any pathological process such as pitting due to phagocytic action such as a sequestrum shows, and no layer of granulation tissue or fibrous tissue on the deep surface. On the other hand, the deep surface had in many cases all the appearances of a fractured surface. The series examined has included many of the specimens from pathological museums labelled 'quiet necrosis'.

3. In those cases where it has been possible to ascertain whence they have arisen, they are found to arise from those parts of the joint surfaces most exposed to injury.

4. They often present to the naked eye the form of grooves on the articular surface associated with fracture of the subjacent bone of traumatic origin.

5. Although many of the bone-corpuscles are dead in cases where the loose body consists of bone in addition to cartilage, yet it is clear that their death has taken place *after* and not before detachment, and this fact cannot therefore be adduced in favour of some pathological process such as 'quiet necrosis'. In the experiments to be described below, identical appearances are seen, and here there can be no question that the death of the bone-corpuscles must have taken place *after* detachment of the loose body. We see exactly

the same behaviour of the bone-corpuscles in experimental bone-grafting; for Hey Groves, Axhausen, and others have shown that the majority of the bone-corpuscles in a bone-graft die. We shall refer to this again later.

Moreover, as previously mentioned, in the only case in the whole series where there was no history of injury, and where we should expect to see marked evidence of some pathological process such as 'quiet necrosis', we find that *the bone-corpuscles are all living*

To sum up the pathological data: the naked-eye and microscopical features of this group of loose bodies demonstrate that they are detached by trauma.

***B.*—Deductions from the Clinical Data.—**

1. *The Traumatic Factor.*—Martens, who made an analysis of König's cases, found that out of a series of 54 cases there were 20 with a definite history of antecedent trauma, and 34 where this was absent or of an insignificant nature. But, as we have shown above, all figures not based upon microscopic examination of every case are fallacious owing to the way in which the solitary osteo-arthritic loose body may simulate the traumatic type.

In my own series of cases quoted above, all of which were examined microscopically, there were 16 cases—of these, 3 cases had no accompanying history and may be discarded for statistical purposes, leaving 13 with an accompanying history. In 12 out of the 13 there was a definite history of antecedent trauma, 6 being cases of direct and 6 of indirect injury.

FIG. 377.—Wedge-shaped fragment detached by traction from external condyle in cadaver.

In only one case was there no history of antecedent injury, *yet in this case not only the cartilage cells but all the bone corpuscles were perfectly healthy, and there was no sign whatsoever of any morbid process.* The clinical evidence from this source strongly supports, therefore, the traumatic origin of this group.

To further investigate this point I searched through the surgical records of St. Bartholomew's Hospital, and found that in the last seventeen years there have been 20 cases of solitary loose body operated upon. These were not all examined microscopically, and therefore almost certainly include a certain number of the solitary pathological variety; yet in no less than 80 per cent of these cases was there a definite history present. If we were able to exclude the pathological type in this series it is obvious that the percentage would be still greater. Surely it is reasonable to assume that in the small percentage of cases remaining, in which no history of injury is present, *leading questions were asked as to a direct injury, and the possibility of indirect was overlooked or forgotten.*

But it may be asked: How can indirect injury lead to a detachment of a portion of the articular surface? I believe that in many cases they are pulled off by the crucial ligaments, and it is certainly remarkable that these bodies are commonly derived from the area near the attachment of one or other crucial ligament. *Fig.* 377 shows the knee-joint of a full-term fœtus in which, by fully flexing the knee and then internally rotating, a very large piece of the inner portion of the external condyle of the femur has been wrenched off.

Then another and, I believe, not infrequent detachment by indirect injury is produced by violent tension upon the posterior ligament of the knee-joint, which it will be remembered is attached immediately adjacent to the articular margin and is powerfully reinforced by the tendons of the gastrocnemius and semimembranosus muscles.

Sir Anthony Bowlby has drawn attention to a specimen in St. Bartholomew's Museum, consisting of two portions of cartilage which were removed by operation from the knee-joints of a boy, age 18, by Holden, and each exactly resembles the cartilage over

the posterior aspect of the condyles. There was a year's interval between the two operations.

2. *The Interval occasionally occurring between an Injury and the onset of the Classical Symptoms of a Loose Body.*—Supporters of the theories of 'quiet necrosis' or 'osteochondritis dissecans' lay considerable stress upon this interval. Yet this interval can be satisfactorily explained if we bear in mind that the classical symptoms are due to the loose body being caught between the articular surfaces, this giving rise to sudden attacks of pain or even locking. If the loose body has become attached to the synovial membrane in such a position that it is unable to wander freely about the joint or get between the articular surfaces, or if it has not been completely detached and occupies a pit in the articular surface, then *the classical symptoms may not arise.* Should it eventually become completely free, more definite symptoms may arise.

The clinical evidence would therefore appear to favour strongly the traumatic origin of loose bodies of the 'classical' type.

C.—Deductions from Experimental Observations.—

1. *Experiments upon the Cadaver.*—Although it is scarcely logical to argue from the dead to the living, yet I have been able, exercising quite moderate violence, to detach both completely and incompletely portions of the articular surface of the femoral condyles in the cadaver. I found that a blow by a hammer upon the lateral margin of the condyle (*Fig.* 378) produced a detachment of a portion of articular cartilage, this detachment usually occurring through the brittle calcified zone. If, however, the surface of the condyle was struck, a much greater degree of violence was necessary to detach a portion of the articular surface. I have already referred to my artificial production of loose bodies by tension upon the crucial ligaments.

FIG. 378.—Articular cartilage detached by direct violence in cadaver.

2. *Experiments upon Animals.*—These yield results of great interest. I describe here a typical experiment upon the knee-joint of a rabbit, where a small portion of the articular end of the femur was detached by a chisel after opening the joint, the artificially-produced loose body being subsequently examined.

1st Operation.—The right knee-joint of a rabbit was opened from the inner side. A small portion of articular cartilage, with a portion of the subjacent bone, was chiselled off—the portion involving the inner lip of the trochlear surface of the femur and a small portion of the inner condyle of the femur. The portion was completely detached and pushed up into the suprapatellar recess of the joint. The joint was then closed, the incisions in the capsule and skin being separately sutured with catgut and a collodion dressing applied. *2nd Operation.*—The joint was reopened five weeks later, and the loose body found to have acquired a secondary attachment to the synovial membrane of the suprapatellar pouch. This attachment was divided with scissors and the loose body removed.

Microscopical examination revealed characters almost identical with those seen in *Case* 1, p. 510, and the general features resemble a loose body of the classical type in that the majority of the cartilage cells are perfectly healthy but many of the bone-corpuscles are dead. But the latter must have died *after* detachment; therefore it seems reasonable to assume that the bone-corpuscles in the classical type of loose body have also died after the detachment by trauma, and that their death is not due to any morbid pathological process.

The experimental data thus, in addition to the pathological and clinical data, are consistent with the traumatic origin of the classical type of loose body occurring in joints.

SHORT REVIEW OF THE PRINCIPAL LITERATURE DEALING WITH THE STRUCTURE AND NUTRITION OF ARTICULAR CARTILAGE AND OF THE BEHAVIOUR OF TRANSPLANTED CARTILAGE.

1. JOSEPH TOYNBEE, working at the Royal College of Surgeons of England, in 1841, described the capillary loops lying immediately beneath the layer of articular cartilage, and concluded that from this subarticular plexus exuded the lymph from which the cartilage derived its nourishment.
"The Non-vascularity of Certain Animal Tissues", *Phil. Trans.*, 1841, part 2, 159.

2. PETER REDFERN, while Professor of Anatomy and Physiology at Aberdeen in 1851, published his researches. He performed no less than 90 operations upon animals to investigate the healing of cartilage. His conclusions were that there was no reproduction of cartilage.
A Normal Nutrition in Human Articular Cartilage, 1850, Edinburgh.
"On the Healing of Wounds in Articular Cartilage", *Month. Jour. Med. Sci.*, 1851, xiii, 201.

3. ALEXANDER OGSTON, in the year 1875, came to the conclusion that the middle zone of the articular cartilage was reproductive in character, and that it made good the constant attrition of the superficial layers and the losses occasioned in the deepest layer by the inroads of adjacent osteoblasts.
Jour. Anat. and Physiol., 1876, x, 49; 1878, xii, 503.

4. OLLIER found that perichondrium alone or cartilage alone could not be successfully transplanted from one animal to another, but that cartilage transplanted *with* its perichondrium lived. However, there was no reproduction of cartilage substance.
Traité expérimental et clinique de la régénération des os, 1868, Paris.

5. BERT transplanted portions of the spinal column of rats, and found that the cartilaginous elements of the graft increased in size.
Recherches expérimentales de la vitalité propre des tissus animaux, 1866, Paris.

6. S. G. SHATTOCK transplanted fœtal rabbit-bones beneath the skin of the doe, and obtained active and marked proliferation of the epiphyseal cartilage of the ends of the bones.
Proc. Roy. Soc. Med. (Path. Sect.), iii, 127, Shattock, Seligmann, and Dudgeon.

Grafting of Joint-ends.—Lexer records some remarkable results from this procedure, which had previously been experimentally performed by Axhausen upon animals. Lexer resected the head of the tibia on account of a myeloid tumour, and replaced it by the corresponding part from an amputated limb. The result was functionally perfect. He also resected a tuberculous joint in a girl of 18, and substituted for it the knee-joint from a recently amputated limb. The result was again successful.

Kuttner's cases of joint-transplantation are of particular interest, as in two of them the joints were subsequently examined some time afterwards and microscopical examination showed survival of the *articular cartilage*; but the absence of cells from the compact bone showed it to be necrosed.

Axhausen's animal experiments showed practically the same thing, viz., that the articular cartilage of the transplanted joint-end lived, whereas most of the cells of the compact bone were necrosed, a few only being living.

Arch. f. klin. Chir., 1909, xc, 263; *Ibid*, 1912, xcix, 1; *Verhandl. d. deuts. Ges. f. Chir.*, 1913, xlii, 353.

2. DEDUCTIONS UPON CARTILAGE VITALITY, GROWTH, AND REPAIR, AND UPON THE NUTRITION OF ARTICULAR CARTILAGE, TO BE DRAWN FROM A STUDY OF THE PATHOLOGICAL DATA.

A.—**Vitality of Articular Cartilage.**—The first fact of interest to be noted is that the behaviour of the cartilage cells demonstrates that their vitality has been considerably underestimated. A loose body of the traumatic type when free in a joint is essentially an autoplastic graft surrounded by the synovial fluid, and when the loose body is composed of both cartilage and bone we have an excellent opportunity of observing and comparing the behaviour of these two substances. One then observes that the cartilage cells retain their vitality in almost every case and after a time actively proliferate, but that the majority of the bone-corpuscles die, as do also the contents of the bony spaces. As we have mentioned previously, we see the same difference in behaviour between cartilage cells and bone-corpuscles after transplantation of joint-ends.

B.—**Growth and Repair of Articular Cartilage.**—Present-day teaching is largely based upon the experiments of Redfern, performed in pre-antiseptic days. The general conclusions drawn from these experiments was that cartilage cells were destitute of the powers of repair. Yet there can be no doubt that the phenomena described above refute the conclusions arrived at by the earlier experiments. At present I am performing a series of experiments upon animals in order further to investigate growth and repair in cartilage, and which will be made the subject of a further communication.

C.—**Growth and Repair of Cartilage other than Articular.**—Professor Shattock has kindly allowed me to reproduce in this connection one of his hitherto unpublished

observations. *Fig.* 379 shows the reparative production of new cartilage from the cut edges of one of the tracheal rings which was divided six years previously in a tracheotomy. The opposite edge of the cut surface of the same ring showed precisely the same repair. The actual interval between the two is filled with dense fibrous tissue. The specimen was obtained from a boy, age 15, upon whom tracheotomy had been performed six years previously. This specimen shows with almost startling clearness *that cartilage cells are capable of growth and repair.*

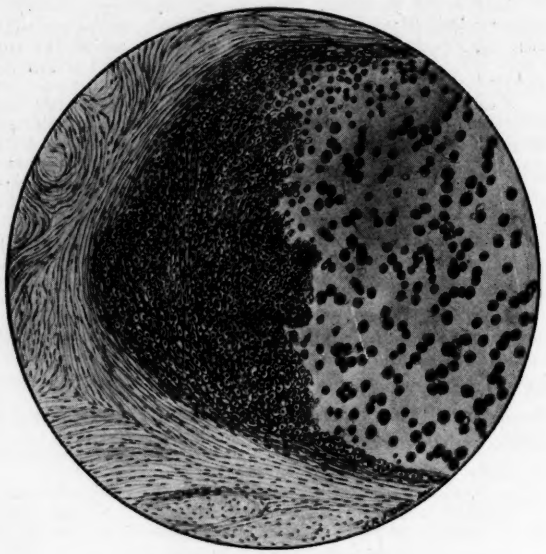


FIG. 379.—Budding cartilage from end of tracheal ring divided in tracheotomy.

D.—**Nutrition of Articular Cartilage.**—Dr. Strangeways ("Observations on the Nutrition of Articular Cartilage", *Brit. Med. Jour.*, 1920, May 15), who has also observed the cartilage proliferation in loose bodies, argues from this that the articular cartilage normally derives the greater part of its nourishment from the synovial fluid. Although it is clear that a loose body *may* derive its nutriment from the synovial fluid, yet I do not think this proves that it normally derives its nutrition in this way.

We must not ignore two other possible sources :—

a. Plasma exuded from capillaries lying in the cancellous spaces abutting on the calcified layer of the articular cartilage.

b. Plasma exuded from the plexus of vessels lying beneath the synovial membrane at the margin of the articular cartilage (circulus articuli vasculosus).

When, therefore, a portion of articular cartilage is detached, forming a loose body, it may merely be that it changes its source of plasma from the subarticular vessels to that of the synovial fluid. Its continued vitality or growth in the latter does not seem, therefore, a conclusive argument that this is its normal source of nutrition. This subject requires further investigation, and has a very important bearing upon the pathology of osteo-arthritis.

Application of these facts to Cartilage-grafting.—Owing to the inherent vitality of cartilage cells, it is clear that the use of cartilaginous grafts in surgery is based upon sound principles. Morestin has done excellent work in this connection, and has used autogenous grafts of costal cartilage to repair defects in the cranial wall and facial skeleton.

3. DEDUCTIONS TO BE DRAWN FROM A STUDY OF THE 'CLASSICAL' TYPE OF LOOSE BODY UPON THE BEHAVIOUR OF THE BONE-CORPUSCLES IN AN AUTOGENOUS GRAFT.

From a study of the pathological appearances in the cases that we have described of loose bodies of bone and cartilage *quite free* in the joint, it is clear that, except in one case, the majority of the bone-corpuscles were dead, as exemplified by the lacunæ no longer holding stainable cells, and by the fact that the spaces contain nothing that stained and were, in fact, empty. Furthermore, in *not a single case was there any evidence of proliferation of osteoblasts with formation of new bone.*

Yet we see a striking difference on examining those bodies of traumatic origin and containing bone which have acquired an early adhesion to the synovial membrane. For in these cases fresh capillaries can be seen to have penetrated the cancellous spaces, and active proliferation of osteoblasts with formation of new bone is taking place. Exactly

the same thing can be observed in the experimental production of loose bodies which show secondary attachment to the synovial membrane with active proliferation of bone-cells.

These observations therefore support Hey Groves' contention that the osteogenic cells in the Haversian canals and cancellous spaces of an autogenous bone-graft actively proliferate only if the graft becomes to some extent vascularized by the ingrowth of capillaries from surrounding parts.

As therefore the vascular supply appears to be of such paramount importance in the osteogenetic function of the bone-graft, it would appear to be advantageous to retain the periosteum in order to enable the graft to establish its vascular connections as rapidly as possible.

And in grafting cartilage the indication would appear to be to retain the perichondrium in order to supply an additional aid to any further production of the cartilage.

IV.—DIAGNOSIS AND TREATMENT.

Diagnosis of the Traumatic Loose Bodies.—Considerations of space will not permit the enumeration of a number of case histories, and compel me to summarize my conclusions from these. If we bear in mind the pathological and experimental data, it will help us to understand the often extremely puzzling symptoms to which a loose body may give rise. We have seen that a portion of the articular surface may in the first place be incompletely detached, in which case it may lie snugly in place, flush with the articular surface; or, on the other hand, it may be capable of considerable movement. Secondly, the detached portion may be quite free in the joint. Thirdly, it may acquire a secondary adhesion to the synovial membrane.

Now the classical symptoms of a loose body, which are sudden attacks of severe pain, often followed by swelling or momentary locking, are due either to the body becoming suddenly and momentarily nipped between the articular surfaces or between the capsule and the joint ends. These symptoms cannot arise when either the body is firmly attached to the synovial membrane at some point where it cannot get between the articular surfaces, or when it is incompletely detached and lies snugly *in situ*. Bearing these facts in mind, it is possible to describe three different groups into which the symptoms fall, and place side by side with the symptoms the corresponding pathological picture.

Group 1.—A portion of articular surface is completely detached; wanders freely about joint; and after an interval becomes secondarily attached to synovial membrane.

An injury, direct or indirect, is followed almost immediately by classical symptoms; and after an interval these disappear.

Group 2.—The portion of articular surface is completely detached, becomes almost immediately adherent to synovial membrane; but after an interval it becomes detached therefrom.

An injury, direct or indirect, is followed by freedom from classical symptoms; but after an interval the latter symptoms arise.

Group 3.—A portion of the articular surface is *gradually* detached; at length it becomes freely movable or completely detached.

Here the process of gradual detachment is accompanied by attacks of pain and swelling, often increasing in severity, and these are followed at last by the classical symptoms. These again may disappear when the body becomes secondarily attached to the synovial membrane.

Symptomatology of the Pathological Varieties.—The symptoms to which the solitary osteo-arthritic body or the solitary synovial chondroma may give rise are almost identical with those we have already described.

When, however, multiple synovial chondromata are present, we find that, as a rule, owing to their number and smaller size, the bodies are apt to become caught between the joint surfaces much more frequently. This occurrence is, however, not associated with such pain or inconvenience to the patient as in the case of the solitary varieties.

Treatment.—The treatment in the case of the traumatic loose bodies and of the synovial chondromata is, in most cases, removal.

In the former group, provided the aseptic technique is beyond reproach, the results are naturally good, since they usually occur in a joint that is otherwise normal. However, if the traumatic loose body has been allowed to remain in the joint long enough to cause a chronic villous synovitis or commencing osteo-arthritis, although we may cure the sudden attacks of pain due to the body becoming impinged between the articular surfaces, yet the operation may be followed by pain, swelling, and feeling of weakness in the joint due to the superimposed condition. This forms one argument for early operation, another being that the presence in a joint of a loose body is a source of danger, as when a loose body suddenly becomes impinged between the articular surfaces of the knee when crossing a crowded street. These propensities of loose bodies also interfere with athletic pursuits.

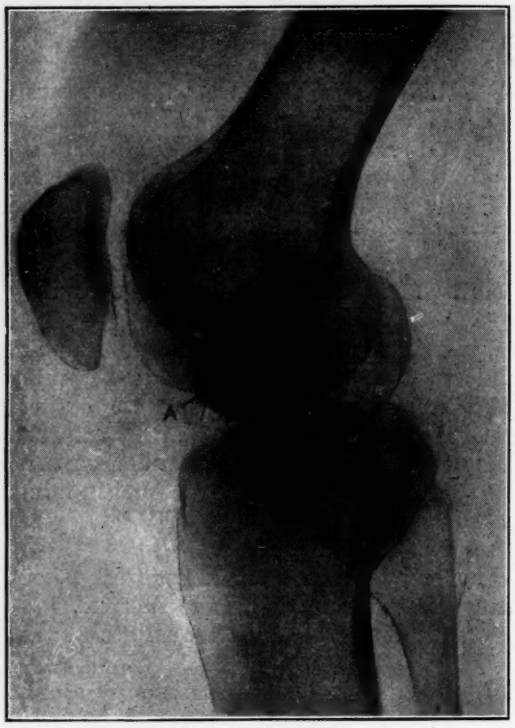


FIG. 380.—Skiagram showing loose body of classical form, including bone.

In the case of the pathological loose bodies in osteo-arthritis, an operation is usually indicated in young or middle-aged people when troublesome locking occurs, and when the joint is not seriously disorganized. The operation has naturally no effect on the course of the disease, and is of a palliative nature.

The results of operation in the synovial chondromata are also good provided the condition is not progressive, for the process may end as suddenly and mysteriously as it commences. If we are lucky enough to operate when the process has come to an end, the result is generally good; if not, further operations may be required.

I saw recently a man who, fifteen years ago, while in India, had over 700 cartilaginous loose bodies removed from his left knee. On examination his knee appeared perfectly normal, and it caused him no trouble whatsoever.

Any operation for removal of a loose body or bodies should be preceded by an *x*-ray examination taken in two planes, from which we may learn how and where to open the joint. An *x*-ray is only helpful when the loose body contains bone. *Fig.* 380 shows a skiagram of one of my own specimens that contained bone which, however, was of new formation, as a large number of previous *x*-rays showed nothing, although definite signs were present. In every case our incision through the skin and capsule should be liberal, in order to explore the joint as thoroughly as possible. To transfix and remove the loose body through a button-hole incision is an unscientific procedure reminiscent of pre-antiseptic days, for unless we explore the joint we are very apt to overlook other loose bodies or co-existent conditions which may give rise to a recurrence of the symptoms.

It is my pleasant duty to express my indebtedness to Professor S. G. Shattock, who has throughout the research given me the benefit of his help, advice, and criticism, and has also kindly placed at my disposal the pathological collections at the Royal College of Surgeons and at St. Thomas's Hospital. To the Medical Research Council, under whose auspices the research has been conducted, my thanks are also due.

I am also indebted to Dr. T. H. G. Shore, Curator of the Pathological Museum of St.

Bartholomew's Hospital, to Dr. H. M. Turnbull, of the London Hospital Pathological Institute, and to the curators of many other London and provincial pathological museums, for the loan of specimens. To the Council of the Royal College of Surgeons and to Professor Keith I am indebted for laboratory accommodation at the College ; and to many kind friends at the Ministry of Pensions my thanks are due for the facilities provided me for observation of joint cases.

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DOWNWARD DISLOCATION OF THE PATELLA.

By H. RUTHERFURD, Glasgow.

In the last twenty years three cases of this injury have come under my care.

1. The first of these was reported in the *Lancet* of June 22, 1901, along with a case in the reverse direction by Dr. David Newman. A young man, age 18, had struck his knee against a bogey or truck which was standing in his way, and was thrown down by the violence of the impact. It is to be noted that this does not seem to indicate a high degree of violence. On examination, the opinion was formed that the edge presenting was the lower border, and that the upper border was engaged between the femur and the tibia. This was confirmed by the skiagraph, after failure to reduce by manipulation. A horse-shoe flap was turned up as in operating for fractured patella, and a hook having been passed through the capsule the bone was pulled out and into place over the condyles of the femur. Recovery with good knee.

Owing to the reflection of this flap I was able to see that both patellar ligament and quadriceps tendon were intact.

2. Francis C., age 42, admitted to Glasgow Royal Infirmary on July 9, 1920. Had been knocked off a ladder from a height of about 10 feet, landing on his right knee. There was a punctured and contused wound over the right patella, and that bone was first thought to be the subject of a comminuted fracture. A few days later it was noted: "The patella is fixed, and forms an unusual prominence between the femur and the tibia. The skiagraph shows what has happened: the upper edge of the patella, with apparently some part of its anterior surface, has been torn away and remains with the quadriceps tendon; the bone itself has been turned vertically through a right angle, being engaged between the femur and the tibia". Again a flap was turned up; the capsule was found untorn; an incision was made on the inner side, and the patella was levered into position. A skiagraph showed good contact between the shell-like fragment and the main portion which had been dislocated. Result: a useful knee, with only a slight restriction of movement. The patient declined further treatment.

3. Donald A., age 7. Admitted Nov. 18, 1920, having been knocked down by a tram-way car, sustaining multiple injuries to head and limbs. There was much swelling of the left knee, and there was thought at first to be a fracture of the patella. A skiagraph, however, showed simple dislocation as in *Case* 1. No dissection was done. The reduction was effected by an elevator through a cut to the side of the patella. Good result. The patient was examined six weeks later, and all movements were normal.

As to the occurrence of fractures of the patella in such a young subject, Reichel (Bergmann, Bruns, and Mikulicz) says: "Below the age of 20, fractures of the patella have been observed very rarely, almost never in children under 10." According to Arthur Thompson in Cunningham's *Anatomy*, the centre for ossification appears about the third year and spreads more particularly over its deeper surface. Two centres vertically disposed have also been described. Ossification is usually completed by the age of puberty.

As regards the dislocation downwards, the same author, Reichel, is able to quote only four cases. What he regards as the most characteristic case, inasmuch as the extension apparatus at the knee was not interrupted, was complicated by tearing of the cruciate and external lateral ligaments of the knee. In this case also it is to be noted that the articular surface of the patella looked upwards; that is to say, the lower edge was engaged between the bones. In this respect it agrees with the case reported by Dr. Newman along with my first one in the *Lancet*. The other three cases quoted by Reichel were complicated by tearing through of the quadriceps tendon at its insertion.

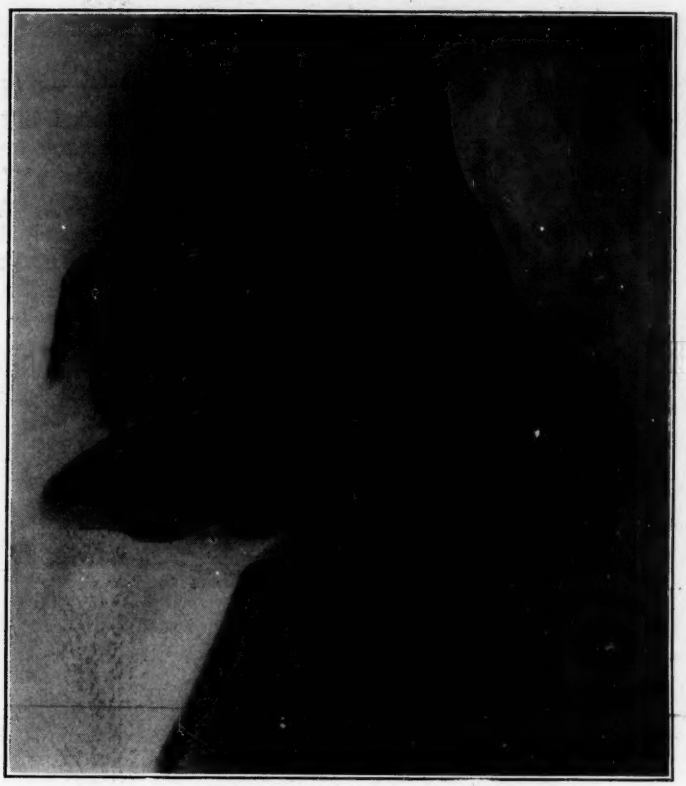

FIG. 381.—*Case* 2. Before reduction.

FIG. 382.—*Case* 2. After reduction.

Stimson (*Fractures and Dislocations*, 1899, p. 772) has expressed his opinion thus: "Dislocations (of the patella) upwards and downwards should not, I think, have a place in the classification, since they are the secondary results of other lesions, rupture of the ligamentum patellæ or the tendon of the quadriceps, which are to be deemed the principal or controlling ones". The same view is set forth by Stephen Smith in his edition of Hamilton on *Fractures and Dislocations* and by Berger (art. 'Rotule', *Dictionnaire Encyclop. des Sciences Médicales*, 1877), who quotes Malgaigne, and before him Pétit, as having enunciated the doctrine. Both in causation and in result a tearing across of the tendon of the quadriceps is distinguishable from a partial tearing out of the patella from the deep surface of that tendon, and this is what, in the cases here put on record, must be supposed to have taken place.

FIG. 383.—*Case* 3. Showing the dislocation.

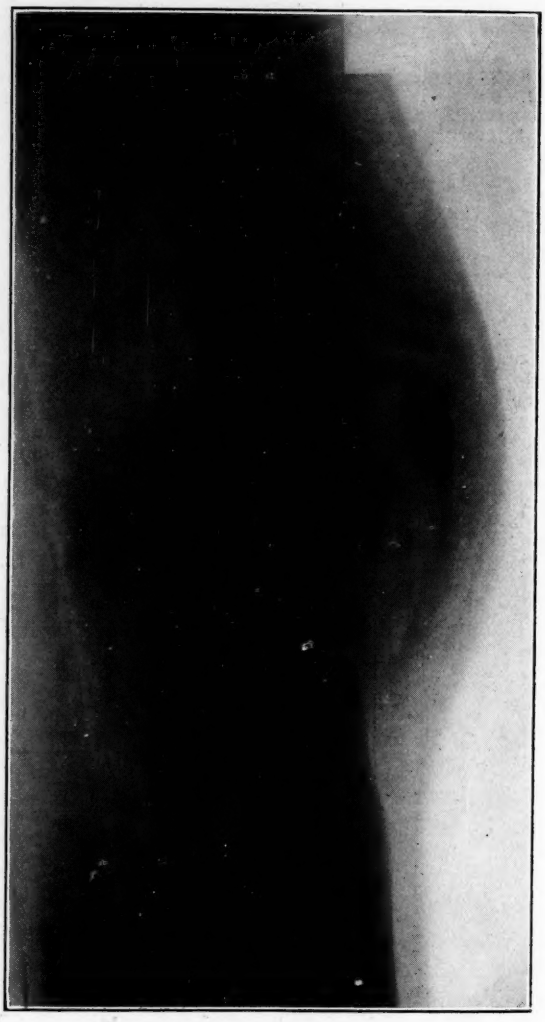

FIG. 384.—*Case* 3. After reduction.

The tearing away of a bony shell with the tendon in the second case, and the integrity of the more or less cartilaginous patella in the child of 7, are not difficult to understand, if we are right in supposing that the displacement is caused by a blow on the patella with the knee flexed. The further flexion is carried, the smaller the surface in contact with the condyles; let the blow be directed downwards as well as backwards, and it will be easy for the upper edge of the patella to slip under the condyles, or, in the case of the young child, to squeeze through between them.

CARCINOMA OF THE BREAST.

By G. W. NICHOLSON, London.

Sir G. Lenthal Cheatle has published two admirable papers in Nos. 30 and 31 of this Journal on the subject of cancer of the breast. I am in the most cordial agreement with all his chief arguments and conclusions. As they were written primarily from the point of view of a surgeon, and are of equal, or even greater, interest to the pathologist, I venture to make a few comments on them from the point of view of the latter.

His three principal conclusions are the following: —

1. That cysts are the result of epithelial proliferation, and that most of them are better described as fusiform dilatations of the ducts.

2. That carcinoma of the breast arises, much more commonly than is generally supposed, in the epithelium of ducts.

3. That cysts of the breast are dangerous.

Cheatle has very clearly, in my opinion, demonstrated the truth that cyst formation progresses hand in hand with epithelial proliferation, of which it is frequently a result. This does not apply to the breast alone, but is equally true of papillomata of granular kidneys, to mention but one example. He has done much to reconcile me to the teaching of the French school, that cystic disease of the breast is a new growth, a cystoma.

I am prepared to agree with Cheatle when he maintains that all, or almost all, carcinomata of the breast are of duct origin. Only in a minority, although a fairly large one, can this be proved with more or less certainty. Unless I am much mistaken, this was the view insisted on many years ago by the late Professor Kanthack, who, however, never wrote on the subject to my knowledge. But the thing is obvious to anyone who uses his eyes in addition to the microscope. The spherical, rather pale cells with distinct nuclei that make up the bulk of carcinomata of the breast, are identical with those found in ducts whose epithelium has proliferated. They are not commonly met with in the latter structures, it is true, but I have seen them on several occasions. Again, they are to be found in many intracystic growths of undoubted duct origin, side by side with the characteristic tall columnar cells. Yet again, in many instances of ordinary 'carcinoma simplex' the large 'laciform' masses can be found in sections, and I have, on several occasions, traced the featureless infiltrating spheroidal cells to them. As a pathologist, I must protest against the use of the term 'metaplasia' in describing the change from the cylindrical to the spherical form. It is used to describe a very different set of phenomena. Nor can I quite agree with the idea that this change is of the nature of a reversion to a lower type. It is simply one of form, and expresses an accommodation to differences in environment. But these are very minor points.

I fully appreciate the difficulty of determining whether the delicate cylindrical cells arise from ducts or from acini, and have often puzzled over this point myself.

But, leaving practical experience aside for the moment, it is to be expected on purely theoretical grounds that a carcinoma should originate in the epithelium of a duct. It is less differentiated than that of secreting acini, and therefore better able to proliferate. Pathologists have sadly neglected the importance of Schaper and Cohen's[1] great paper, in which they show that epithelial organs contain growth centres which are less differentiated than the rest of the epithelium, supply the material for growth during the later stages of development, regenerate the normal wear and tear of the tissue, and respond to pathological stimulation by active proliferation. In compound secreting glands these areas are represented by the junctional ducts between the secreting acini and large ducts. It is here, in my opinion, that cancer of the breast actually begins in the majority of cases.

It is because it begins here that it is so difficult to decide, by the form of the cells, whether they be derived from acini or ducts. Next in frequency as sites of cancer formation come the larger ducts, and last of all the secreting acini, since it requires a much more profound degree of dedifferentiation (a process which, as I believe, does occur) to enable them to reassume the function of growth.

One of the great merits of Cheatle's papers, from the point of view of the pathologist, is to have adduced strong evidence that, in the breast, the growth centres of Schaper and Cohen are situated in the ducts. The second and greatest merit of the papers lies in the fact that they have given one more, and that a severe, blow to Cohnheim's theory of the importance of 'embryonic' displaced cells in tumour formation. I must confess to being one of those who, after contemplation of the photograph,[2] doubt the malignancy of the breast illustrated in *Fig.* 99, although I agree with the author in that, had the case passed through my hands, the surgeon would have been advised to remove the breast if he had not already done so. This difference of opinion is therefore of no vital importance, and I only mention it to emphasize the point I desire to make. In the breast can we trace, better than in almost any other organ, all the stages, from simple hyperplasia of epithelium through excessive hyperplasia to blastomatous proliferation. It is the second of these stages that I believe *Fig.* 99 to represent, a stage which in itself is not as yet definitely carcinomatous, but which we have learnt to regard with grave suspicion.

I am far from wishing to uphold the view so obnoxious to Ribbert and others that cancer spreads by a process of infection, and that a carcinoma, once it is definitely established, ever grows by other means than by division of its own cells. But I have insisted for years that hyperplasia passes insensibly into carcinoma, and that this gradual change can nowhere be better studied than in the breast, and that tumour formation is here-multi-, or rather omni-centric. Unless we adopt the absurd position that hundreds or thousands of 'embryonic' cells are scattered about in the ducts in cases of mammary cancer, these gradations completely knock the bottom out of the universal applicability of Cohnheim's theory. That it holds for some tumours I do not for one moment deny. I therefore agree with Cheatle, when he points out the importance of irritation in neoplasia. What the change from orderly to disordered and blastomatous proliferation may happen to be, we do not know. Perhaps in some cases it is no more than a difference in degree and extent of proliferation.

There can, I believe, be no difference of opinion as to the danger of cystic changes in the breast.

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INSTRUCTIVE MISTAKES.

A BILIARY MISTAKE AND ITS CORRECTION.

A WOMAN, age 37, presented herself for pain in the region of the gall-bladder. There was evidently cholecystitis. An exploratory operation revealed the presence of an inflamed gall-bladder containing a stone the size of a ripe acorn. Both bladder and stone were removed. In ligating the cystic duct, the mistake was made of drawing up a part of the common bile-duct, and throwing the ligature around the side of this duct. Five weeks later the wound opened and discharged bile. Before long the whole of the bile secreted was voided through the fistula, the motions became devoid of bile, and the patient gradually lost weight. Later the abdomen was opened again and a stenosis of the common bile-duct discovered about the middle of the tube. The fistula communicated with the proximal half. The question naturally arose as to what should be done, and it was decided to try the effect of dividing the stenosed portion longitudinally, and of suturing the opening thus made transversely. With some difficulty this was carried out. Bile escaped through the abdominal wall for ten days, and then ceased, the wound healed, the motions regained their colour, and the patient put on weight.

[A similar mistake was made in another case, in which removal of the gall-bladder was begun at the cystic duct. This mistake can be avoided by dissection downwards of the gall-bladder.]

FISTULA IN ANO AND AMŒBIC DYSENTERY.

AN ex-service man, age 22, presented himself at hospital complaining of a fistula in ano. The man was thin, and complained of 'diarrhœa' which he had had since 1918, when he was in France. He gave a history as well which suggested, at any rate, tuberculosis, and it was thought he might have a tuberculous colitis with its common concomitant, an anal fistula. A sigmoidoscope was passed, and it was evident at once that the lower bowel was greatly inflamed, thickened, and rigid; but the condition did not suggest tuberculosis so much as some chronic infection. Diarrhœa and pain still remaining urgent symptoms, it was decided to perform an inguinal colostomy in order to put the lower bowel at rest. The operation did not, however, produce the desired result, for diarrhœa still went on.

This man had never been east of France, and amœbic dysentery was not dreamed of until the condition obviously called for a closer scrutiny of the fæces than had previously been made, and then the amœba of dysentery was found quite easily.

CEREBRAL SYPHILIS OR CERVICAL RIBS.

A WOMAN, age 46, was admitted to hospital with the diagnosis of 'cervical ribs', because she had symptoms which suggested an additional rib, namely weakness and wasting of the ulnar group of muscles of the right hand, and *x* rays showed a cervical rib on each side. The diagnosis indeed was only doubted after a careful dresser had recorded in his notes that the patient had had a transient unilateral facial paralysis. This suggested the possibility of cerebral syphilis, and examination of the cerebrospinal fluid and the Wassermann test confirmed this diagnosis.

The cervical ribs which undoubtedly were present had no part in the causation of the muscular weaknesses.

SHORT NOTES OF RARE OR OBSCURE CASES.

A CASE OF PARAPLEGIA IN WHICH THE SECOND CERVICAL VERTEBRA WAS REMOVED: WITH A NOTE OF THE PATIENT'S CONDITION SEVENTEEN YEARS LATER.

By J. HOGARTH PRINGLE, Glasgow.

A schoolboy, age 14, who had been admitted to the Medical House of the Glasgow Royal Infirmary under the care of the late Dr. John Lindsay Steven on May 6, 1903, was transferred to my ward on the following day, as his condition was very urgent. He was suffering from almost complete paraplegia: the paralysis was complete in both his upper limbs and in the right lower limb, but not absolute in the left lower extremity.

The history given was that he had suffered from enlarged glands in the upper part of his neck two years prior to this, at which time he also complained of severe pains in the head. Ten months ago it was noticed that he had slight difficulty in moving his left upper limb, and that in walking his left foot dragged. At the end of two months this had cleared up, and the patient was apparently well until the onset of his present illness, five weeks before admission. At that time it was noticed that his right lower limb began to drag. This was attributed to a fall fourteen days previously. Three weeks before admission he had apparently lost all power in the right lower limb, and a week later power began to go from the right upper extremity. This was followed by loss of power in the left upper limb, and then in the left lower extremity. There had been no pain in the head and no vomiting since the present paralytic condition commenced. The patient lay on his back, his head fixed; the slightest attempt at movement of his head caused intense pain in the back of the neck. He was unable to move either of his upper limbs or his right lower extremity. Feeble movements of flexion and extension could be made in his left lower extremity at the hip- and knee-joints. Both knee-jerks were present and exaggerated. Ankle-clonus was present in both limbs. Superficial reflexes were present in both limbs, but diminished. Babinski's sign was not present. Triceps-jerk was present and exaggerated in both arms. The patient was unable to pass urine, and required a catheter from the time he went into the medical ward. The bowels had not acted after he came into hospital, and it was stated that he had been 'very constipated' for some days before admission. Respiration seemed to be entirely by the diaphragm. There was a pressure-sore over the occiput, and a fluctuating swelling extended from below this to the spine of the last cervical vertebra.

As the boy's condition was very critical an immediate operation was carried out.

An incision was made in the middle line of the neck over the whole length of the swelling, and pus evacuated. The laminæ of the upper four cervical vertebræ were found bared of their soft parts by the pus, and those of the second, third, and fourth vertebræ were removed, and a quantity of extradural pus was evacuated from the spinal canal. The second vertebra (the axis) appeared to be completely separated from all the surrounding soft tissues and to be entirely necrosed. The wound was packed with gauze. The patient stood the operation well, and the following day he was able to raise his right upper limb off the bed, to move both his lower extremities with some freedom, to move all the fingers of his left hand, and flex and extend the left elbow; but he could not raise the arm off the bed. On May 9 he had a dose of castor oil, which was followed by a volun-

tary evacuation of the bowel, and thereafter he had complete control of bowel and bladder. He made good progress until the middle of June, when an abscess on the left side of his neck required to be opened: another formed immediately afterwards on the right side, and was also opened, and it was found that the second vertebra was completely bare and could be palpated from all three wounds in the neck.

As all that remained of this vertebra appeared to be necrosed, as well as a considerable portion of the third vertebra and also the posterior ring of the atlas, at the end of July I removed the whole of the second vertebra except the odontoid process, the greater portion of the third, and the posterior ring of the first vertebra. The odontoid process could not be removed. The left vertebral artery was cut in the course of the operation, but the right one was avoided; it was, however, tied, in case of secondary hæmorrhage. Extension of the neck was continued for some time; the wounds granulated up, and he left hospital on October 10 with good power in all his limbs, and the wounds almost but not absolutely healed.

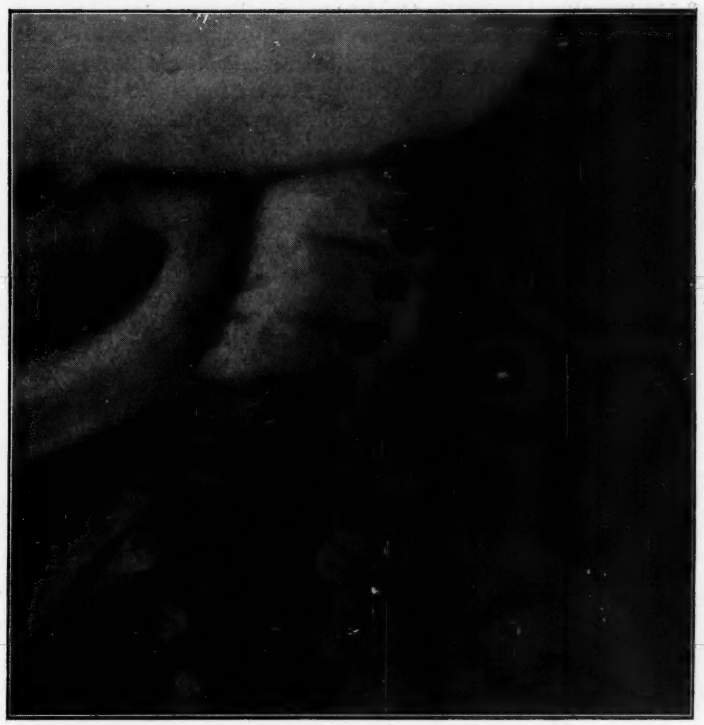

FIG. 385.—From a skiagram, showing the condition of the cervical vertebræ.

The patient was lost sight of, and was not seen until he again presented himself at the hospital on April 2, 1919, complaining of weakness in both upper extremities and left lower extremity, the left upper limb being worse than the right. He also complained of tingling sensations in the hands and fingers. He stated that until quite recently he had been able to work as a member of a riveting squad; but the weakness of his upper limbs, which came on two months ago, and which he attributed to an attack of influenza, had prevented his continuing work. He was taken into hospital. It was found that his knee-jerks were greatly increased, that both ankle- and patella-clonus were present in both limbs, but Babinski's sign could not be obtained. The triceps-jerk in both limbs was much exaggerated. Tactile sensation in the hands was not affected. His grasps with dynamometer (outside scale) were: right 35, left 40. He was able to flex and extend his head slightly, but rotation of the head was completely abolished. His neck appeared curiously shortened, but there was no angular deformity. He was kept in bed with extension applied to the spine. When he was dismissed, on June 3, the abnormal sensations had entirely disappeared and his grasps had increased to 70 and 75 respectively. An *x*-ray examination shows a curious deficiency in the cervical vertebræ. The exact number of vertebræ present is not quite clear, but it seems certain that two are absent. The seventh is quite distinct as a separate entity; the others appear to have become synostosed, at any rate through their processes, as shown in *Fig.* 385. It has not been possible to get a better radiogram in consequence of the fact that he is unable to rotate his head.

He was seen last on November 11, 1920, and seems to be much better than he has been at any previous visit here. The abnormal sensations have gone from his fingers and hands, though he says that his hands "feel as if they were shrivelling". His stereognostic sense seems to be defective, and he says he has difficulty with coins in consequence. His reflexes remain practically the same as noted above.

The record of this patient seems to be sufficiently interesting to justify its being reported. His condition on admission to hospital could scarcely have been more serious, and the very rapid recovery of function of the spinal cord after the relief of pressure was as gratifying as it was striking. It is hardly less interesting that he ultimately became so well that he was able to work many years in a riveting squad—a job which, if it brings in better pay than most others, certainly entails extremely hard work.

At the time of the operation in 1903, the opinion regarding the lesion was that it was a tuberculous condition of the cervical spine. After the abscess was opened and the state of the bones was seen, it appeared more probable that the real nature of the disease was a subacute osteomyelitis. Unfortunately there is no record of the temperature, nor of a bacteriological report on the pus, to be found at this date.

It is an interesting speculation as to how the 'slack' of the spinal cord became accommodated after the removal of the bone. Beyond the shortening of the patient's neck there is no sign of any deformity of his spine.

LIGATURE OF THE HEPATIC ARTERY.

By R. ECCLES SMITH, Barry, Glam.

Injury to the hepatic artery during the performance of choledochotomy has been held over the head of the surgeon like the sword of Damocles. Happily, so far I can find in the literature no case in which it has occurred. Here it necessitates deliberate ligature of the artery, and ends in recovery with apparently no ill effects, immediate or remote.

Mrs. W., age 59 years, more than reasonably stout, had been the subject of so-called 'bilious attacks' for a period of some years, until a final attack ended with a marked jaundice for some days, and a persistent slight icterus for three or four weeks, when she was referred to me with the true diagnosis of cholelithiasis with an impacted stone in the common duct.

Operation.—A good exposure of the site of operation was obtained by the 'Mayo Robson' incision. The fundus of the gall-bladder was freed of adhesions to the colon and the pylorus, and found to contain about 35 moderate-sized faceted stones. A larger stone was found fixed and immovable low down in the first part of the common duct. Owing to the inability to 'rotate' the liver, work on the common duct was carried out at a great depth. An incision over the stone failed to permit its evacuation, and on enlarging this incision, rather alarming arterial bleeding occurred. The stone was rapidly removed, and repeated unsuccessful attempts were made to pick up the bleeding point. Packing being of no avail, the hepatic artery was deliberately defined by dissection and controlled. As the general condition of the patient was not of the best, a ligature was passed and the artery tied. The hæmorrhage ceased instantly. Cholecystotomy and drainage of the common duct and right kidney pouch completed the operation.

After-History.—On recovery from shock, a fair degree of jaundice lasted for about ten days, and then rapidly disappeared. Escape of bile continued from the sinus for five weeks, and then ceased. Unfortunately parietal sepsis supervened, and a ventral hernia subsequently developed. For six months the patient remained free from any of her old 'bilious' complaints, and was extremely well, with no jaundice, no loss of weight. The urine was free from albumin and sugar. In the seventh month I again admitted her with all the signs and symptoms of an acute infection of the gall-bladder, slight rigors, temperature 102° to 103°, pulse 110, and tenderness over the gall-bladder. Expectant treatment was adopted for seven days. I then injected collosal manganese intramuscularly, and, after two injections at twenty-four hour intervals, the temperature dropped and remained normal until her discharge from hospital fourteen days later.

I have no doubt whatever that, in the depths of the wound, in making what appeared to be the usual incision into the common duct, I injured the hepatic artery—whether abnormally placed or distorted I do not know; but what I regarded as a surgical disaster, to be followed at least by some grave alteration in the general metabolism of the patient, fortunately proved to be of little consequence.

I am much indebted to Dr. Ernest Davies, Barry, for his able assistance, and to Dr. Neilson, Barry, for the trying adminstration of the anæsthetic.

CHOLELITHIASIS: NOTES ON A CASE WITH A CALCIFIED GALL-BLADDER.

By PHILIP TALBOT, Stalybridge.

W. L., male, age 56, a patient of Dr. Awburn, of Mottram, gave a history of having had attacks of biliary colic without jaundice for about fifteen years.

An *x*-ray examination showed the outline of a calcified gall-bladder containing calculi and a dilated and calcified cystic duct (*Fig.* 386).

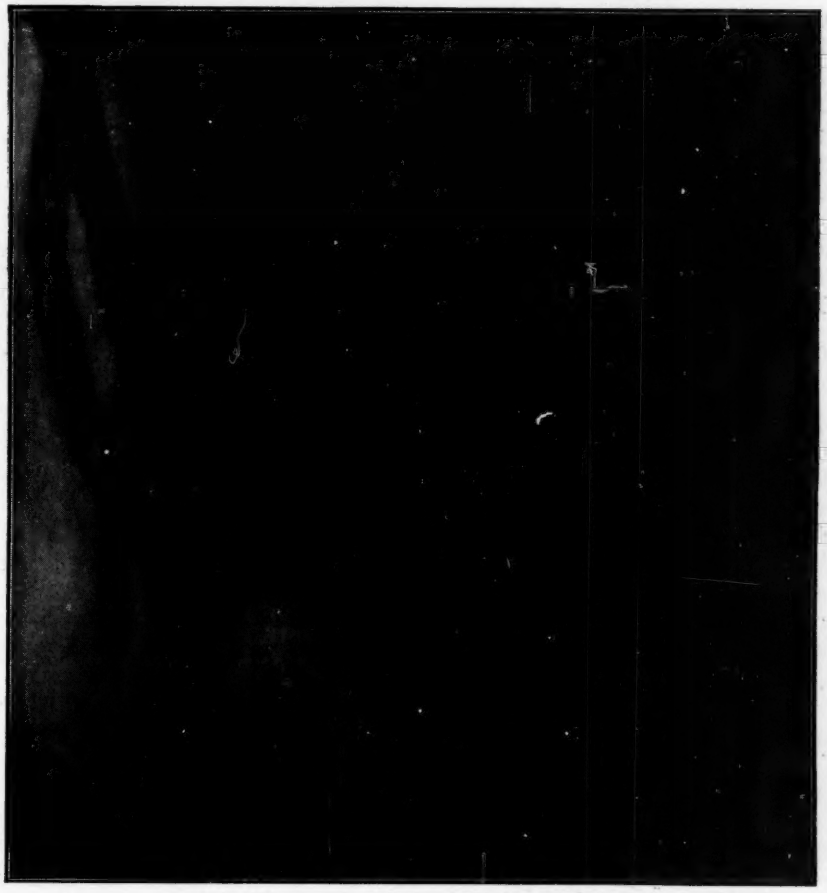

FIG. 386.—Skiagram of calcified gall-bladder and cystic duct.

Operation, Feb. 28, 1920.—The gall-bladder, which was found buried in a mass of adherent omentum, felt very hard and stony, and was packed tightly with calculi. The cystic duct for about one-and-a-half inches was dilated to a diameter of three-quarters of an inch, its walls showed calcareous plates, and it also was packed with calculi. The last inch of the cystic duct was normal in size and appearance. The gall-bladder and dilated duct were removed. There were no calculi in the common duct.

SEVERE INTESTINAL HÆMORRHAGE FOLLOWING APPENDECTOMY.

By F. C. PYBUS, Newcastle-on-Tyne.

This complication following appendectomy is unique in the author's experience, and seems worthy of record.

W. T., age 47, was admitted to the North Riding Infirmary, Middlesbrough, in July, 1920, as a case of chronic appendicitis. When 15 years of age he had what appeared to be a mild attack of appendicitis lasting three or four days. The attack subsided; but since then he has had several recurrences at almost yearly intervals. Seventeen years ago he commenced to pass blood per rectum, and since then he has occasionally passed similar blood when constipated. The blood was bright in colour and occurred at stool.

Fifteen years ago he had a very severe attack of pain in the abdomen. The pain was most intense in the neighbourhood of the umbilicus and in the appendix region. During the attack, which lasted three weeks, he was very constipated, but had no sickness or vomiting. Since then the attacks of pain had been gradually getting worse. For many years he had suffered from gastric trouble—heartburn, waterbrash, and ulcers on the tongue and lips.

On July 22 appendectomy was performed. There was a post-operative rise of temperature to 100° which lasted twenty-four hours. On the fourth day his temperature rose to 101°, and on the following day reached 102°, with pulse 130. On the eighth day his temperature was normal, and it remained so except for an occasional rise to 99° until the thirteenth, but during this period his pulse remained between 90 and 120.

On Aug. 12 he passed two pints of dark blood from the bowel, together with a clot about the size of a small orange, which was also dark in colour. All this time he had a slight tenderness in the right iliac fossa, but no pain. After this the bowels were moved every second day by means of enemata, but at each action a little altered blood was passed. During this time he had fever up to 100° till Aug. 23, on which day he had a very severe hæmorrhage from the bowel, followed by a subnormal temperature.

While in Middlesbrough I was asked by Dr. George Longbotham to see him. On examination he was profoundly anæmic, slightly tender over the operation area, and had small hæmorrhoids which did not appear to have given rise to any recent bleeding. I was unable to give any definite opinion as to the cause of the hæmorrhage, and could elicit no symptoms or signs of a duodenal ulcer. It was decided to perform a laparotomy, which I carried out on Aug. 30.

On opening the abdomen the operation area was first examined. A coil of the lower end of the ileum was found adherent near the appendicular stump, and this part was put aside for further investigation. The rest of the viscera were examined, and no evidence of any ulceration or lesion could be detected. A re-examination of the cæcal area revealed a coil of ileum adherent near the apex of the cæcum and to the mesentery of the appendix, which was very much thickened. The ileum was separated off, and its raw edges were covered up. A small perforation was found at the apex of the cæcum, near what must have been the stump of the appendix, and, adjoining this, a hæmatoma about the size of a filbert nut was found between the layers of the appendicular mesentery, containing some recent and also laminated clot. On removal of the clot, bleeding occurred. This was controlled by a fresh ligature of the mesentery proximal to the hæmatoma. The perforation of the cæcum was then closed.

Except for some slight post-operative fever and œdema of the leg, he made a good recovery, and is now well.

The explanation of this condition seems to have been that the appendicular artery was punctured, and formed a hæmatoma in the mesentery, which became adherent to the cæcum and an adjacent coil of ileum. This, with or without suppuration, perforated the cæcum and gave rise to the melæna. It would appear safer in these cases, when the appendicular vessels cannot be seen and avoided, to ligature the mesentery after clamping rather than to puncture it with a needle or forceps.

REVIEWS AND NOTICES OF BOOKS.

Privy Council Medical Research Council: First Report of the Committee upon Injuries of the Nervous System. 1920. London: H.M. Stationery Office.

A VERY strong Committee has been occupied for nearly two years in investigating and recording the effects of injuries to the peripheral nerves, and this Report gives fully the results of their labours. In itself it constitutes the most complete account of the subject with which we are acquainted; and it provides us with a mass of detailed information of the highest value. Much of the ground has doubtless been covered by the published papers of the last few years; but it is nowhere so completely surveyed as in this Report, and the judicial analysis of the physician and anatomist adds greatly to the value of surgical investigation.

While it would be impossible to review briefly the mass of detail here supplied, we may refer to a few salient points. In cases of extensive separation of cut ends a two-stage operation is strongly advised, the end bulbs being tied together at the first operation, the nerve stretched for two or three weeks, and resection with suture then completed. For sutures, linen thread and silk are preferred to catgut, as the latter "causes more cellular reaction" and "it is doubtful whether this disadvantage is compensated for by its greater absorbability". A 'retention' suture through the nerve is condemned, as is continuous suture of the cut ends, which is stated to interfere with the escape of exudate from the interior of the nerve, and to be liable to produce a stricture. All methods of envelopment of the sutured ends are condemned.

As regards the vexed question of nerve-grafting, it is stated that "when it is impossible to obtain approximation of the ends of a divided nerve, the outlook is extremely bad, for there is at present no known method which can take its place. It is therefore of the utmost importance that every possible manœuvre should be employed and every means exhausted for securing end-to-end approximation before trying the last resort of grafting. Lateral implantations and flap operations are only mentioned here to be condemned. There is nothing in what is at present known of the processes of regeneration of nerves to justify them, and no unimpeachable evidence that they have ever been successful. Bridging of the gap with a piece of nerve, whether living or alcoholized, is justified on histological grounds, by experimental work on animals, and by a few clinical cases of very imperfect recovery. But in the present state of our knowledge nerve-grafting ought to be regarded as a last resort."

In an addendum are quoted some important cases of bridging by graft or by 'lateral implantation' (Joyce), showing that "in exceptional cases grafts have produced more successful results than previous experience had justified any hope for"; but "the result of these investigations in no way alters the view, expressed in the text of the Report, that nerve-grafting should only be adopted as a substitute for end-to-end suture in those very rare instances where it is absolutely impossible to bring about direct approximation."

The whole Report is not only valuable in itself, but an admirable example of the value of collective investigation of the results of treatment by a committee of men with many-sided views.

Collected Papers of the Mayo Clinic, Rochester, Minnesota. Vol. X, 1918. Edited by Mrs. M. H. MELLISH. Large 8vo. Pp. 1196 + x. 1919. Philadelphia and London: W. B. Saunders Co. Ltd. 36s. net.

IT is no doubt a result of the late war that the character of the bulk of the papers which make up this volume differs somewhat from that of its forerunners, for naturally many of the clinicians had their minds fully occupied with other matters. This is not meant to indicate any falling off in quality from their former high level, though one must as a surgeon confess to a sense of personal loss in the relative absence of those comprehensive and instructive papers on abdominal surgery from which we always derived a degree of educational advantage which no other surgical publication competed with.

Of the clinical articles, chief place must be given to that on the *Cutaneous Aspects of Tuberculosis*, by J. H. Stokes; this should appeal to the surgeon no less than to the dermatologist, for the author gives some most illuminating suggestions as to the relationship of the surgical treatment of tuberculous glands and tuberculides, and urges both a sounder selection of cases for operation and its more thorough performance.

In Balfour's practical and beautifully illustrated article on *End-to-end Anastomosis between the Small and Large Intestine* we miss any reference to Lane's practice of this method during the past ten years or more. The same author's further paper on *Cautery Excision of Gastric Ulcer* appears to vindicate entirely the claims made in the first article for this method, as judged by observations of the results which it has given; the paper contains much practical advice as to the choice of cases for this method, and points in its technique.

We have read Judd's observations or review of *The Recurrence of Symptoms following Operations on the Biliary Tract* with the greatest interest, for the question of cholecystectomy *v.* cholecystotomy has vexed us for some years. We are not aware of any other observations on operative results which have comprised anything like the large number of cases—over 2000—which Judd reviews, and from the study of which he concludes by favouring removal of the gall-bladder as the operation of choice. We must admit to being not quite convinced, and for this reason: if it is admitted that where the gall-bladder alone is involved cholecystectomy is the best operation, it does not necessarily imply that this is also so when, at the first operation, stones are found in the common duct or the history suggests infection of the bile-ducts. If it is agreed that after exploration of the common duct drainage is essential, then it appears to us better to suture the duct itself and drain the gall-bladder rather than to remove the gall-bladder and be compelled to drain the common duct. When infection and stone formation have already involved the ducts, removal of the gall-bladder can no longer be advocated as a preventive measure, and appears to us to lose its chief indication. Our views are, of course, founded upon a very small experience when compared with the Mayo clinic's 2000 cases, so we should much value Judd's opinion upon the point raised.

Mann's papers on *Surgical Shock* contain an adequate review of the present beliefs, and if they do not contain original observations or suggest any fresh hypothesis as to the causation of shock, they throw out some helpful suggestions. We turned with pleasant expectation to MacCarty's *Biological Conception of Neoplasia*, but it was altogether beyond us, and appears too involved and elaborate to provide a practical basis for teaching purposes.

If no special attention is called to shorter papers, this is not intended to convey that they are of less value than those which have been referred to. To many surgeons the Mayo clinic volumes are their most valuable reference library, and we trust that enough has been said of the contents of the volume under notice to indicate that it does not fall short of its predecessors in interest to surgeons of all types.

Lippincott's Quick Reference Book for Medicine and Surgery. By GEORGE E. REHBERGER, A.B., M.D., Johns Hopkins University. Philadelphia and London: J. B. Lippincott Company. 63s. net.

THIS extensive work reviews in a clear and concise manner the causation, symptomatology, clinical features, prognosis, and treatment of the various disorders met with in the practice of general medicine and surgery, including their specialized branches. It also contains a well-chosen list of the drugs in common use, with a brief description of their nature, dosage, and mode of action.

The text is fully and admirably illustrated. The book has been written primarily to meet the needs of the general practitioner in providing him with reliable and readily accessible summaries of the diseases which he may encounter; this object has been well attained, and fully justifies the immense labour which its achievement must have entailed.

Surgical Pathology and Morbid Anatomy. By Sir ANTHONY BOWLBY, K.C.B., F.R.C.S., and Sir FREDERICK W. ANDREWES, M.D., F.R.S. Royal 8vo. Pp. 651, with 210 illustrations. Seventh edition, revised. 1920. London: J. & A. Churchill. 30s. net.

THE seventh edition of this work is up to the standard set by its predecessors, and we believe that it will command the popularity which they have always enjoyed.

The newly added chapters on tetanus, gas gangrene, and shock are good, and the illustrations throughout the book have been greatly improved, though there are still, perhaps, not quite enough of them.

On the whole, however, we must confess, on reading through it, to a sense of disappointment. The authors' claim in their preface to have revised the whole book is scarcely borne out by the obvious neglect of some of the most important sections. In the chapters on diseases of bone, for instance, no mention at all is made of osteitis fibrosa, and the description of the odontomes is so antiquated as to be not only useless, but misleading to the student. Surely our knowledge of these tumours has not remained stationary since the publication of the late Sir Frederic Eve's paper in 1883. In the chapter on diseases of the breast, again, the recent work on Paget's disease of the nipple might have been mentioned, and we thought that the term 'sarcomatous', as applied to the rapidly-growing fibro-adenomata, had long since been abandoned. In the section on the kidneys the misleading statement is made that sarcoma is the commonest malignant tumour, and

the terato-blastomata of infants are not clearly dissociated from them. It is a pity that these and other similar instances of lack of revision should mar an otherwise excellently written book, especially as it is the only one on surgical pathology commonly read in, at any rate, the London medical schools.

A Synopsis of Surgery. By ERNEST W. HEY GROVES, M.S., M.D., B.Sc. (Lond.), F.R.C.S. (Eng.), Surgeon to the Bristol General Hospital, Lecturer on Surgery in the University of Bristol. Fifth edition. 8vo. Pp. 628, illustrated, 1920. Bristol: John Wright and Sons Ltd. 17s. 6d. net.

THE book has been revised, some excellent outline drawings in colour have been added, and methods evolved during the war have been incorporated; the technique of primary and secondary suture of wounds is described; but the new methods of plastic surgery are not mentioned. There is a clear account of blood transfusion, with the group tests of donors and recipients.

The sections dealing with fractures have been brought up to date by the inclusion of recent non-operative and operative measures, and many new illustrations added. In discussing the treatment of acute appendicitis, the author does not emphasize the urgent necessity of immediate operation, or point out the serious consequences which may result from expectant treatment. In the description of the surgical treatment of gall-stones, it is not clear when cholecystotomy or cholecystectomy is indicated. The book should appeal to busy practitioners and students as a handy work of reference giving the outlines of surgical diagnosis and treatment.

Chirurgische Anatomie und Operationstechnik des Zentralnervensystems (Surgical Anatomy and Operative Technique of the Central Nervous System). By TANDLER and RANZI. Pp. 159, 94 illustrations, mostly coloured. 1920. Berlin: Springer. 56 marks.

THIS handsomely illustrated volume is the joint production of a distinguished anatomist and surgeon in Vienna, and its scope is clearly indicated by its title. There is no discussion of the conditions which call for operation or of the results of operation; but the surgical anatomy of the brain and spinal cord with their coverings is fully described and illustrated, as are the details of operative methods.

Probably the most striking feature of the book is the profusion of illustrations, which are in part diagrammatic and in part actual pictures of the stages of operation. These are so numerous and clear that to anyone reasonably familiar with the subject they convey their own interpretation and make the text almost unnecessary. For English readers, perhaps, the principal value of the work will thus lie in its graphic representation of anatomical detail; and it will find a useful place on the table of the surgeon who is only occasionally called upon to perform the more elaborate operations upon the central nervous system. The appended bibliography is mostly confined to German literature.

The Student's Synopsis Series: Surgery: By IVOR BACK, F.R.C.S., Surgeon to St. George's Hospital, and A. TUDOR EDWARDS, F.R.C.S., Assistant Surgeon to Westminster Hospital. 8vo. Pp. 480. 1921. London: J. & A. Churchill. Price 15s. net.

THE authors have attempted to give the main facts of surgical theory and practice in less than five hundred small pages, and in this rather difficult task they have shown some skill in the selection of the most important subjects, in the omission of unimportant ones, and in great condensation.

The price charged seems rather high for a small unillustrated book, but we suppose that students will be willing to pay this if it helps them to pass an examination.

INDEX TO VOLUME VIII.

PAGE

ABDOMEN and chest combined, wounds of, causing early fatality - - - - 194
— wounds of, causing early fatality - - 196
Abdominal operations, quinine and urea injections in - - - - - - - 34
— surgery at Prof. Henri Hartmann's clinic - 223
— — Sir A. Lane's clinic - - - - - 221
— — regional anæsthesia in (*see* Regional Anæsthesia)
Abnormal ulnar nerve in forearm, section of - 139
Abnormality, congenital, of female genito-urinary organs - - - - - - 377
Abyssinia, appendicitis in - - - - - 176
Achlorhydria in pernicious anæmia - - 336
Acute encysted hydrocele of the spermatic cord 40
Addison's anæmia (*see* Pernicious Anæmia)
Adhesions, pleural, found at autopsy in cases of early fatality seen at a casualty clearing station - - - - - - - - 195
Æneas wounded in thigh, and extraction of dart by Iapyx - - - - - - - 7
Africa, appendicitis in - - - - - - 176
Age and sex incidence in appendicitis - - 189
— — — series of 500 goitre operations - - 413
Aleppo button (*see* Baghdad Boil)
America, appendicitis in - - - - - 176
American College of Surgeons, presentation of great mace to, by consulting surgeons of British armies - - - - - - - 237
Amœbic dysentery and fistula in ano, the former undiagnosed, case of - - - - - 529
Amputation, technique of re-amputation after 88, 92
Anæmia, pernicious, Addison's, or idiopathic (*see* Pernicious Anæmia)
— splenic (*see* Banti's Disease)
— in splenic disease - - - - - - 327
Anæsthesia in goitre operations - - - 438
— pre-operative use of morphine and other alkaloids in - - - - - - 34
— in Rammstedt's operation - - - 400
— regional (*see* Regional Anæsthesia)
Anæsthetic in Babcock's operation for varicose veins - - - - - - - - 487
— of choice in regional anæsthesia - - - 279
Anæsthetist, qualifications necessary in regional anæsthesia - - - - - - - - 279
Analgesia, 'splanchnic' (*see also* Regional Anæsthesia) - - - - - 278, 283
Anatomy and physiology of spleen - - - 313
— teaching in 16th century - - - - 245
Auerbach's plexus, condition in cystic dilatation of cæcum and intestinal stasis - 456
Aneurysms in neck - - - - - - 167
— traumatic, due to gunshot injuries - - 126
Angeiomatosis, capillary, of parotid gland - 481
Angioma, treatment by radiation - - 77, 79
Animals, appendicitis in - - - - - 177
Appendectomy, severe intestinal hæmorrhage following - - - - - - - 534
Appendicitis, acute, simulated by gall-stone with perforative cholecystitis - - 370
— — — inflammation of Meckel's diverticulum - - - - - - 136
— in Africa - - - - - - - 176
— age and sex incidence in - - - 174, 189
— in America - - - - - 176, 187
— — animals - - - - - - - 177
— — Asia - - - - - - - - 176
— causation - - - - - - - 171

PAGE

Appendicitis, cellulose-containing foods in relation to - - - - - - - - - 184
— distribution in community - - - - 174
— — national - - - - - - 175, 187
— in Europe - - - - - - - 175
— hospital figures - - - - - - 172
— literature - - - - - - - 171
— in Polynesia - - - - - - - 177
— proximate causes of - - - - - - 185
— Registrar-General's returns of mortality - 171
— in relation to chronic intestinal stasis - - 186
— — concretions - - - - - - 186
— — dental caries and nasal sinusitis - - 183
— — other diseases - - - - - - 185
— — food preservatives - - - - - 184
— — food-stuffs - - - - - - 178
— — foreign bodies - - - - - - 186
— — kinks - - - - - - - 186
— — menstruation - - - - - - 186
— — *oxyuris* - - - - - - - 186
— — trauma - - - - - - - 186
— ultimate cause - - - - - - 177
Appendix, acute obstruction of, due to carcinoma - - - - - - - - 392
— carcinoma of, causing diverticula of appendix and acute appendicular obstruction 392
— diverticula of, due to carcinoma - 392, 396
— intussusception of - - - - - - 227
Apprenticeship, surgical, in 16th century 243, 244
Artery, carotid, thrombosis following shell wound - - - - - - - - 200
— — traumatic aneurysm of - - 168–70
— hepatic, ligature of - - - - - - 532
— persistent vitelline, fatal intra-abdominal hæmorrhage from rupture of - - 478
— — — method of development - - - 479
Arthritis, acute, due to infection, loose bodies in joints resulting from - - 494, 499
Articular cartilage (*see* Cartilage)
Ascites due to chronic intussusception of several months' duration - - - - - 366
Asia, appendicitis in - - - - - - 176
Association of Surgeons of Great Britain and Ireland - - - - - - - 1
— — — — — inaugural address - - 6
Atheromatous carotid artery infected as a result of shell wound - - - - - 200
Atropine before operations - - - - 34
Avian clubs - - - - - - - - 11
Axolotl and tiger salamander, effect of thyroid feeding - - - - - - - - 9

BABCOCK'S operation for varicose veins (*see also* Varicose Veins) - - - 486
— — — — anæsthetic employed - - 487
— — — — details of 20 cases traced after operation - - - - - 490
— — — — optimum position in - - - 487
— — — — simultaneous ligature and division of communicating veins - - 487
Baghdad boil, clinical types of - - 259, 260
— — diagnosis and treatment - - - 261
— — tartar emetic in - - - - - - 261
Bananas in relation to appendicitis - - 180
Banti's disease and splenic anæmia, clinical history - - - - - - - - 349
— — — — diagram showing chief changes in 348
— — — — differential diagnosis - - 350

PAGE

Banti's disease and splenic anæmia, historical and general account - - 347
— — — — pathogenesis - - - - 352
— — — — in relation to the spleen - - 347
— — — — splenectomy in - - - 352
— — — — treatment - - - - 352
BARLING, SIR H. G.: Division of posterior spinal roots for relief of pain due to complete disruption of brachial plexus 142
Basra date-mark (*see* Baghdad Boil)
Bed trolley in use in Sir W. Thorburn's clinic at Manchester - - - - - - 474
BELL, SIR CHARLES, biographical notes of - 389
Benign duct papilloma of breast - - - 289
— and malignant changes in duct epithelium of breast - - - - - - - 285
— tumours, treatment by radium and *x* rays 77
Benzol treatment of leukæmia - - - 342
BERRY, JAMES: Clinic at the Royal Free Hospital - - - - - - - - 361
— — On a further series of 500 goitre operations, with special reference to after-results - - - - - - - 413
— — Papilloma of bladder of unusual size - 374
— — Perforation of ureter by calculus: extravasation of urine: death from uræmia and sepsis - - - - - - 372
Bilateral gland operation in cancer of the tongue - - - - - - - - 84
Bile-duct, common, inadvertent ligation of - 529
— — injury of hepatic artery in incision of - 532
Bile-pigment, influence of spleen in formation - - - - - - - - 318
Biliary mistake and its correction, a - - 529
Biographical Notes:—
Sir Charles Bell - - - - - - 389
Sir William Blizard - - - - - 3
Thomas Gale - - - - - - 145
Birds, effects of glandular activity on - - 11
Bismuth paste and B.I.P.P. methods of closing bone cavities - - - - - - 460
Bladder and male genital organs, radium treatment of malignant disease of - 36
— malignant growths of, treatment by radium 37
— papilloma of unusual size - - - - - 374
BLAND-SUTTON, SIR JOHN: Science and surgery (Inaugural Address, Association of Surgeons of Great Britain and Ireland) - 6
BLAXLAND, A. J.: Intussusception of the vermiform appendix - - - - - 227
BLIZARD, SIR WILLIAM, biographical notes of 3
Blood changes after splenectomy - - - 317
Blood-clot method of closing bone cavities, Schede's aseptic - - - - - 460
Blood-corpuscles, red, relation of spleen to destruction of - - - - 317, 318
Blood-vessels, specimens showing the effects of gunshot injury of - - - 107, 121
Boil, Baghdad (*see* Baghdad Boil)
Bone cavities, septic, following gunshot wounds, closure by muscle flaps - - - - 460
— — — — — — — — — — contra-indications 470
— — — — — — — — — — detailed notes of 24 cases - 470
— — — — — — — — — — end-result in cavity - - 470
— — — — — — — — — — muscles used in various regions 465, 466
— — — — — — — — — — technique - 462
— — — — — — — — — — time of healing after operation 470
— — — — — — — types - - - - - 463
— — — — — — various methods of closure 460
Bone-chip method of closing bone cavities - 460
Bone-chips separated by chiselling in sinus operations, importance of removing 463, 464

PAGE

Bone-corpuscles in autogenous graft, deductions upon behaviour of, to be drawn from study of 'classical' type of loose body in joint - - - - - - 520
Bone-marrow, secretion by spleen of substance acting on - - - - - 319
Bony and cartilaginous loose bodies in joints, with special reference to pathology and etiology (*see also* Loose Bodies in Joints) 493
Brachial plexus, complete disruption of, division of posterior spinal roots for relief of pain due to - - - - - - - 142
Bradshaw Lecture: The surgery of the spleen 307
Breast, benign duct papilloma of - - - 289
— cancer, origin of - - - 163, 285, 527
— — spread of - - - - - - 160, 527
— — without clinical signs - - - - 303
— carcinoma of - - - - - - - 527
— cysts and primary cancer in cysts of 149, 285, 527
— — treatment - - - - - 163, 528
— ducts, epithelium of, benign and malignant changes in - - - - - - 285, 527
— massive cholesterin deposits in, in cases of long-standing mastitis - - - 59
— primary duct cancer of - - - 291, 527
Broca's method of closing bone cavities - - 460
BURROWS, HAROLD: Congenital abnormality of female genito-urinary organs - - 377

CÆCUM, cystic dilatation of, character of Auerbach's plexus in - - - - - 456
— — — — fluid contained in cyst - - 453
— — — — mucous membrane - - - 456
— — — — muscular coats - - 454, 459
— — — following intestinal stasis, without intestinal obstruction - - - 452
— — — pigmentation in mucous membrane 456
— — — simulation of ovarian cyst by - - 452
Calcified gall-bladder in a case of cholelithiasis 533
Calculus, perforation of ureter by; extravasation of urine: death from uræmia and sepsis - - - - - - - - 372
— of tonsil of unusual size - - - - 375
Cancer (*see also* Carcinoma; Malignant Disease; Tumours)
— of breast, origin of - - - 163, 285, 527
— — primary duct - - - - - 291, 527
— — spread of - - - - - - 160, 527
— — without clinical signs - - - - 303
— inoperable, treatment with selenium (*see* Selenium)
— possible influence of autolytic products of injured epithelial cells on cell-multiplication in - - - - - - - - 306
— primary, in cysts of breast - 149, 285, 527
— of tongue, removal of lymphatics in 80, 83, 85
Capillary angeiomatosis of the parotid gland, with partial excision - - - - - 481
Carcinoma (*see also* Cancer)
— alveolare solidum simplex - - - - 396
— of appendix causing diverticula of appendix and acute appendicular obstruction - 392
— breast - - - - - - - - 527
— colon simulated by ovarian cyst - - 371
Carcinomatous goitre (*see* Goitre, Malignant and Papilliferous)
Carotid artery, thrombosis following shell wound - - - - - - - 200
— — traumatic aneurysm of - - 168–70
Cartilage, articular, nutrition of - - - 520
— — vitality, growth, and repair of - - 519
— external semilunar of knee, development of cysts in connection with - - - 409
— grafting of - - - - - - - 520
— other than articular, growth and repair of - 519

PAGE

Cartilage, structure and nutrition of articular, and behaviour of transplanted, short review of literature dealing with - - 519
Cartilaginous or cartilaginous and bony loose bodies in joints, with special reference to pathology and etiology (*see also* Loose Bodies in Joints) - - - - - 934
Casualty clearing station, cause of death in cases of early fatality seen at - - 193
Cavities, septic bone, following gunshot wounds, closure by muscle flaps (*see also* Bone Cavities, Septic) - - - - - - 460
Cellulose-containing foods in relation to appendicitis - - - - - - 184
Cerebral syphilis or cervical ribs—question of responsibility for symptoms in case presenting both - - - - - - 529
Cervical rib symptoms masked by gunshot wound of forearm - - - - 226
— ribs or cerebral syphilis—question of responsibility for symptoms in cases presenting both - - - - - - 529
CHEATLE, SIR G. LENTHAL: Benign and malignant changes in duct epithelium of the breast - - - - - - - 285
— — — Cysts and primary cancer in cysts of the breast - - - - - - 149
Chest and abdomen combined, wounds of, causing early fatality - - - - 194
— wounds of, causing early fatality - - 193
China, appendicitis in - - - - - - 176
Cholecystitis, perforative, with gall-stone, simulating acute appendicitis - - - 370
Choledochotomy, injury of hepatic artery in - 532
Cholelithiasis: notes on a case with a calcified gall-bladder - - - - - - 533
Cholesterin deposits, massive, in the breast, in cases of long-standing mastitis - - 59
— — — — — — — microscopic structure of 61
Chondromata, synovial, forming loose bodies in joints (*see* Loose Bodies in Joints)
Cirrhosis of liver, diagnosis from Banti's disease 350
Cleft palate and hare-lip at Sir A. Lane's clinic 222
— — operation at Mr. James Berry's clinic - 364
Clinical and pathological illustrations of diverticulitis - - - - - - - 95
— types of Baghdad boil - - - 259, 260
Clinics, surgical, visits to (*see* Surgical Clinics at Home and Abroad)
Closure of septic bone cavities following gunshot wounds by muscle flaps (*see also* Bone Cavities, Septic) - - - - - 460
Cocoa and chocolate in relation to appendicitis 179
Colectomy at Sir A. Lane's clinic - - - 221
Collateral ligaments of knee-joint, repair of - 266
Colloidal selenium - - - - - - 50
Colon, diverticulitis of - - - - - - 95
— new growth of, simulated by ovarian cyst - 371
COLT, G. H.: Babcock's extraction operation for varicose veins - - - - - 486
Concretions in relation to appendicitis - - 186
Congenital abnormality of female genito-urinary organs - - - - - - 377
— pyloric stenosis (*see* Pylorus; Rammstedt's operation)
Consultation, surgical, in 16th century - - 253
Contusion of spinal cord in gunshot injuries - 209
Coombe's extramucous division of muscle for congenital pyloric stenosis - - - 400
COPE, ZACHARY: Clinical types of Baghdad boil (cutaneous leishmaniasis) - - 259
Corns, treatment by radiation - - - 78
COUTTS, F. J.: Omphalomesenteric cyst causing intussusception - - - - - 228
Cramp with varicose veins - - - - 489
Crucial ligament rupture - - - - - 190
Cutaneous leishmaniasis (*see* Baghdad Boil)

PAGE

Cyst, omphalomesenteric, causing intussusception - - - - - - - - - 228
— ovarian, diagnosed as new growth of colon - 371
— — simulated by cystic dilatation of cæcum 452
Cystic dilatation of cæcum (*see* Cæcum, Cystic Dilatation of)
Cysts of the breast, and primary cancer in 149, 285, 527
— — really parts of dilated and convoluted ducts - - - - - - - 286
— — treatment - - - - - 163, 528
— in connection with external semilunar cartilage of knee-joint - - - - - 409
— at ileocæcal valve - - - - 452, 454

DEATH, cause of, in cases of early fatality seen at a casualty clearing station - 193
Decalcified bone-chip method of closing bone cavities - - - - - - - 460
Deformity in goitre as a reason for operation 424, 428
Denmark, appendicitis in - - - - - 175
Dental caries in relation to appendicitis - - 183
Dermoids in relation to embryology - - 16
Diarrhœa as a complication after Rammstedt's operation - - - - - - - 404
— and vomiting in pernicious anæmia - - 336
DICKSON, J. A.: Treatment of stiff metacarpo-phalangeal joints where there is no gross bony alteration - - - - - - 272
Digestive ferments, influence of spleen on activation of - - - - - - - 319
— system, the spleen as a member of - - 323
Dilatation of cæcum into cyst (*see* Cæcum, Cystic Dilatation of)
Disease, particulate causes of - - - - 8
Disinfection of skin - - - - - - 31
Dislocation of patella downward - - - 524
— traumatic, of knee-joint - - - - - 190
Disruption, complete, of brachial plexus, division of posterior spinal roots for relief of pain due to - - - - - - 142
Diverticula of appendix caused by carcinoma of appendix - - - - - 392, 396
— duodenal - - - - - - - - 18
Diverticulitis, cases of perforation - - - 103
— — stenosis - - - - - - - 98
— — vesicocolic fistula - - - - - 105
— — without symptoms - - - - - 95
— clinical and pathological illustrations of - 95
Diverticulum, Meckel's, inflammation of, simulating acute appendicitis - - - - 163
Division of posterior spinal roots for relief of pain due to complete disruption of brachial plexus - - - - - - 142
DOBSON, J. F., and JAMIESON, J. K.: The lymphatics of the tongue: with particular reference to the removal of lymphatic glands in cancer of the tongue - - 80
Downward dislocation of patella - - - 524
Drainage in goitre operations - - - - 439
DRUMMOND, HAMILTON: Sloughing fibroid of uterus which ruptured through fundus into peritoneal cavity, causing general peritonitis; laparotomy; complete hysterectomy - - - - - - 141
Duck in drake plumage - - - - - - 15
Duct cancer, primary, of breast - - 291, 527
— epithelium of breast, benign and malignant changes in - - - - - 285, 527
— papilloma, benign, of breast - - - 289
Ductless glands, relation of spleen to - - 325
Ducts of breast, cysts of, really parts of dilated and convoluted ducts - - - - - 286
— — in relation to cysts and cancer 149, 285, 527
Duodenal diverticula - - - - - - 18
— ulcer, diagnosis from Banti's disease - - 350

PAGE

Dysentery, amœbic, and fistula in ano, the former long undiagnosed, case of - - 529
Dyspnœa in goitre often due to pressure by least prominent lobe - - - 425, 426
— — as a reason for operation - - - 424
— — tracheotomy in - - - - - - 425
— — *x* rays in determination of site of compression - - - - - - 426

ECCHONDROSIS, epi-articular, detached, forming loose bodies in joints - 494, 496
Education of the public in 16th century to appreciate surgery - - - - 253
— a surgeon in 16th century - - - 240
— — — — — lack of medical education - - 256
— — under Thomas Vicary 240
EDWARDS, A. H.: Operative procedure suggested for the repair of collateral ligaments of the knee-joint - - - - 266
gypt, appendicitis in - - - - - - 177
Eiselsberg's (von) method of closing bone cavities - - - - - - - - - 460
Electroselenium - - - - - - - - 50
Embryology in relation to surgery - - - 16
Empyema, trap-door operation for - - - 64
Encysted hydrocele, acute, of the spermatic cord - - - - - - - - - 40
Endocrine system, relation of spleen to - - 325
Enterolith, intestinal obstruction due to - - 378
Epi-articular ecchondroses, detached, forming loose bodies in joints - - - 494, 496
Epiphyses, detached, forming loose bodies in joints - - - - - - 494, 510
Epithelioma-like form of Baghdad boil - - 261
Epithelium of breast-ducts, benign and malignant changes in - - - - - - 285
Europe, appendicitis in - - - - - 175
Examination of candidates in surgery in 16th century - - - - - - - - 250
Exophthalmic goitre (*see also* Goitre, Exophthalmic)
— — ligation of superior thyroid artery for, at Mr. James Berry's clinic - - 361
— — treatment by radiation - - - 78
Experimental investigation of results of linear division of pyloric sphincter - - 262
External semilunar cartilage of knee, development of cysts in connection with - - 409
Extraction operation, Babcock's, for varicose veins (*see* Babcock's Operation)
Extravasation of urine, with death from uræmia and sepsis, resulting from perforation of ureter by calculus - - - - - 372

FATALITIES, early, seen at a casualty clearing station, cause of death - - 193
Fat-graft method of closing bone cavities - 460
Feathers and testicles of birds, relationship between - - - - - - - 13
Female genito-urinary organs, congenital abnormality of - - - - - - - 377
Ferment secretion by the spleen - - - 318
Fever as a complication after Rammstedt's operation - - - - - - - 405
— in splenic disease - - - - - - 330
Fibrocartilages, interarticular, loose bodies in joints derived from - - - 494, 510
Fibroid of uterus which sloughed, ruptured into peritoneum, and caused general peritonitis - - - - - - - - 141
Fibromyoma of uterus, treatment by radiation 78, 79
Fibular collateral ligament, repair of - - 267
Finland, appendicitis in - - - - - 176
FINZI, NEVILLE S.: The treatment of tumours by radium and *x* rays - - - - 68

PAGE

FISHER, A. G. T.: Study of loose bodies composed of cartilage or of cartilage and bone occurring in joints; with special reference to their pathology and etiology - - - - - - - - 493
Fistula in ano and amœbic dysentery, the latter long undiagnosed, case of - - - 529
— gastrojejunocolic, with stercoraceous vomiting following gastro-enterostomy - 368
— vesicocolic, due to diverticulitis - - - 105
Flail shoulder, successful treatment of case of - 133
Flour, grinding of, in relation to appendicitis - 178
Food preservatives in relation to appendicitis - 184
Foods, cellulose-containing, in relation to appendicitis - - - - - - - 184
Foodstuffs in relation to appendicitis - - 178
Forearm, gunshot wound of, masking symptoms of cervical rib - - - - - - 226
— section of abnormal ulnar nerve in - - 139
Foreign bodies in relation to appendicitis - 186
FORSYTH, J. A. C., and STEWART, M. J.: On the occurrence of massive cholesterin deposits in the breast in cases of long-standing mastitis - - - - - 59
Fractures at Sir A. Lane's clinic - - - 219
FRASER, JOHN, and MCCARTNEY, J. E.: Case of persistent vitelline artery: fatal intra-abdominal hæmorrhage from rupture of vessel - - - - - - 478
Frontier sore (*see* Baghdad Boil)
Functions of spleen - - - - - - 313

GALE, THOMAS, biographical notes of - 145
Gall-bladder, calcified, in a case of cholelithiasis - - - - - - 533
— operations, difficulties in - - - - 28
Gall-stones and acute pancreatitis simulating perforated gastric ulcer - - - 370
— and hour-glass stomach associated with transposition of viscera - - - 137
— with perforative cholecystitis simulating acute appendicitis - - - - 370
Gastric ulcer, diagnosis from Banti's disease, - 350
— — perforated, simulated by gall-stones and acute pancreatitis - - - 370
Gastro-enterostomy for congenital pyloric stenosis - - - - - - - 399
— followed by gastrojejunocolic fistula after gastro-enterostomy - - - - - 368
Gastrojejunocolic fistula with stercoraceous vomiting following gastro-enterostomy 368
Genital organs, male, radium treatment of malignant disease of - - - 36, 38, 39
Genito-urinary organs, female, congenital abnormality of - - - - - - 377
Giants - - - - - - - - - 9–11
Glands, lymphatic, of the tongue; with particular reference to their removal in cancer 80, 83
Glandular activity, effect of, on birds - - 11
— pantheon, the - - - - - - - - 8
Gloves in operations - - - - - - - 30
GODLEE, SIR RICKMAN J.: Introduction to Vol. VIII - - - - - - - - 1
Goitre, dyspnœa due to - - - - - - 424
— — often caused by least prominent lobe 425, 426
— — tracheotomy in - - - - - - 425
— — *x* rays in determination of site of compression - - - - - - - 426
— exophthalmic, deaths from operation for - 442
— — late results of operations for - 445, 447
— — necessitating operation - - 361, 424, 428
— — occurrence in a series of 500 goitre operations - - - - - 416, 421
— 'false' exophthalmic - - - 423, 431
— inflammatory - 416, 419, 420, 421, 424, 431
— intrathoracic - - - - - - - - 434

PAGE

Goitre, intrathoracic, spoon used in operation for 437
— malignant and papilliferous, deaths from operation for - - - - - 442
— — — late results of operations for - 445, 447
— — — necessitating operation - - 424, 429
— — — occurrence in a series of 500 goitre operations - - - - 416, 423
— operations and the parathyroid glands - 451
— retroclavicular and retrosternal - - - 434
— series of 500 operations for, anæsthesia - 438
— — — — complications - - - - - 448
— — — — — recurrent laryngeal nerve paralysis - - - - 448
— — — — — tetany - - - - - 451
— — — — — thyroid insufficiency - - 450
— — — — deaths from operation - - 441
— — — — drainage - - - - - 439
— — — — healing of wounds - - - 440
— — — — intrathoracic goitre - - - 434
— — — — — — spoon used in - - - 437
— — — — late results of operations - - 444
— — — — nature of the goitre - - - 416
— — — — — operation - - - - 432
— — — — principal reasons for operation - 424
— — — — — — — discomfort, deformity, and slight dyspnœa 424, 428
— — — — — — — exophthalmic goitre 424, 428
— — — — — — — 'false' exophthalmic goitre - - 424, 431
— — — — — — — malignant and papilliferous goitre - 424, 429
— — — — — — — palpitation, nervousness, etc. - 424, 431
— — — — — — — primary chronic inflammation - - 424, 431
— — — — — — — suspected malignancy 424, 429
— — — — proportion of hospital to private cases - - - - - 416
— — — — sex and age incidence - - 413
— — — — with special reference to after-results - - - - - 413
— — — — subsequent deaths from causes unconnected with operation - 451
— simple, deaths from operation for - - 441
— — late results of operations for - - 444, 445
— 'thyrotoxic' adenoma - - - - 432
— treatment by radiation - - - - - 78
Graft, autogenous, of bone, deductions upon behaviour of bone-corpuscles in, to be drawn from study of 'classical' type of loose body in joint - - - - - 520
Grafting of cartilage - - - - - - 520
Graves' disease (*see* Goitre, Exophthalmic)
Greece, appendicitis in - - - - - - 176
Gunshot injury of the heart and blood-vessels, specimens showing the effects of - - 107
— wound of forearm masking symptoms of cervical rib - - - - - - - 226
— wounds, closure by muscle flaps of septic bone cavities following (*see also* Bone Cavities, Septic) - - - - - 460
— — of spinal cord, pathology of (*see* Spinal Cord)

HÆMOLYSIN, secretion by spleen of - 318
Hæmolytic jaundice, diagram showing chief changes in - - - - - 354
— — general account of - - - - - 353
— — pathogenesis - - - - - - 356
— — radium in - - - - - - - 356
— — in relation to the spleen - - - 353
— — splenectomy in - - - - - - 356
— — symptoms - - - - - - - 355
— — treatment - - - - - - - 356

PAGE

Hæmopoietic system, the spleen as a member of 320
Hæmorrhage in abdominal wounds - - - 197
— as a complication after Rammstedt's operation - - - - - - - - 403
— fatal intra-abdominal, from rupture of persistent vitelline artery - - - - - 478
— in gunshot wounds of spinal cord - 213, 218
— severe intestinal, following appendectomy - 534
Hæmorrhages, petechial, in splenic disease - 329
Hæmorrhagic diathesis and the spleen - - 331
Hæmothorax, septic - - - - - - 193
Hare-lip and cleft palate at Sir A. Lane's clinic 222
HARTMANN, PROF. HENRI, clinic at Hôtel Dieu, Paris - - - - - - - 223
Heart, specimens showing the effects of gunshot injury of - - - - - - 107, 110
HENRY, ARNOLD K.: Section of abnormal ulnar nerve in forearm - - - - 139
Hepatic artery, ligature of - - - - - 532
Hodgkin's disease, general account of - - 344
— — in relation to the spleen - - - 344
— — splenectomy in - - - - - - 347
— — treatment - - - - - - - 347
Holland, appendicitis in - - - - - - 175
Hour-glass stomach and gall-stones associated with transposition of viscera - - 137
Hydrocele, acute encysted, of spermatic cord - 40
Hypertension in pernicious anæmia - - 336
Hypertrophic stenosis of pylorus, congenital (*see* Pylorus; Rammstedt's operation)

IDIOPATHIC anæmia (*see* Pernicious Anæmia)
Ileocæcal cysts - - - - - 452, 454
Immune substance, secretion by spleen - - 318
Impulse in varicose veins - - - - - 489
Inaugural address, Association of Surgeons of Great Britain and Ireland - - - 6
India, appendicitis in - - - - - - 176
Infection, defensive properties of spleen against 322
Inflammation of Meckel's diverticulum simulating acute appendicitis - - - - 136
Injuries, gunshot, of heart and blood-vessels, specimens showing the effects of - - 107
Inoperable cancer, treatment with selenium (*see* Selenium)
Instructive Mistakes:—
A biliary mistake and its correction - 529
Cerebral syphilis or cervical ribs - - 529
Fistulo in ano and amœbic dysentery - 529
Gall-stone with perforative cholecystitis simulating acute appendicitis - - 370
Gall-stones and acute pancreatitis simulating perforated gastric ulcer - - 370
Inflammation of Meckel's diverticulum simulating acute appendicitis - - 136
Ovarian cyst diagnosed as a new growth of the colon - - - - - - 371
Interarticular fibrocartilages, loose bodies in joints derived from - - - 494, 510
Intestinal hæmorrhage, severe, following appendectomy - - - - - - 534
— obstruction due to enterolith - - - 378
— stasis (*see also* Cæcum, Cystic Dilatation of)
— — Auerbach's plexus in - - - - - 456
— — followed by cystic dilatation of cæcum without intestinal obstruction - - 452
— — pathology of - - 452–6 *passim*
— — pigmentation of intestinal mucous membrane in - - - - -456–9
— surgery at Sir A. Lane's clinic - - - 221
Intestine, diverticulitis of - - - - 18, 95
— perforation of, due to diverticulitis - - 105
— relation of spleen to - - - - - - 325
— wounds of, in cases of early fatality - - 197
Intrathoracic goitre - - - - - - 434
— — spoon used in operations for - - - 437

PAGE

Intussusception caused by omphalomesenteric cyst - - - - - - - - - 228
— chronic, of several months' duration, ascites due to - - - - - - - - - 366
— of vermiform appendix - - - - - 227
Investigation of cause of death in cases of early fatality seen at a casualty clearing station - - - - - - - - 193
Irradiation sickness - - - - - - 76
Italy, appendicitis in - - - - - - 175

JAMIESON, J. K., and DOBSON, J. F.: The lymphatics of the tongue; with particular reference to the removal of lymphatic glands in cancer of the tongue - - 80
Jaundice, hæmolytic (*see* Hæmolytic Jaundice)
— in splenic disease - - - - - - - 329
Jeannel's table showing prospect held out by various forms of operative treatment of varicose veins - - - - - - - 489
Johannesburg, appendicitis in - - - - 177
JOHNSON, RAYMOND: Acute encysted hydrocele of the spermatic cord - - - 40
Joint changes from long-continued presence of loose bodies - - - - - - - 515
— knee, repair of collateral ligaments of - 266
— — traumatic dislocation of - - - - 190
— loose bodies in, composed of cartilage or cartilage and bone, with special reference to their pathology and etiology (*see also* Loose Bodies in Joint) - - - 493
— metacarpophalangeal, stiff, without gross bony alteration, treatment of - - 272
JONES, SIR ROBERT, clinic at Liverpool - - 42

KAYE, CAPT. H. W.: An investigation of the cause of death in certain cases of early fatality seen at a casualty clearing station - - - - - - - - 193
KEITH, A.: Pathological remarks on cysts at the ileocæcal valve, etc.; with contribution to pathology of intestinal stasis 452
KELLY, R. E.: Transposition of viscera associated with gall-stones and hour-glass stomach - - - - - - - - 137
Keloid, treatment by radiation - - - 78
Kinks in relation to appendicitis - - - 186
KNAGGS, R. LAWFORD: Four aneurysms in the neck - - - - - - - - - 167
Knee-joint (*see also* Loose Bodies in Joints; Patella)
— external semilunar cartilage of, development of cysts in connection with - - 409
— repair of collateral ligaments of - - 266
— traumatic dislocation of - - - - 190

LABAT, GASTON: Regional anæsthesia, with special reference to splanchnic analgesia, a new method applicable to abdominal surgery - - - - - - - - 278
Labrador, appendicitis in - - - - - 187
Laminectomy, position of patient in - - 475
Lamps and specialism in surgery - - - 17
LANE, SIR ARBUTHNOT, clinic at Guy's Hospital 219
Laryngeal nerve, recurrent, paralysis of, a complication of goitre operations - 448
Lateral ligaments of knee, repair of - - 266
Leishmaniasis, cutaneous (*see* Baghdad Boil)
Leucocytosis in splenic disease - - - 330
Leukæmia, acute - - - - - - - 341
— chronic - - - - - - - - 341
— diagram showing chief changes in - - 339
— general account of - - - - - - 338
— in relation to the spleen - - - - 338

PAGE

Leukæmia, symptoms of - - - - - 341
— treatment - - - - - - - - - 342
— — by benzol - - - - - - - - 342
— — radium - - - - - - - - 343
— — splenectomy - - - - - - 343, 344
Ligaments, collateral, of knee-joint, repair of - 266
Ligature of hepatic artery - - - - - 532
Ligatures and sutures, material used for - - 33
Linear division of pyloric sphincter, experimental investigation of results - - - 262
Liver, cirrhosis of, diagnosis from Banti's disease - - - - - - - - 350
— relation of spleen to - - - - - - 324
Loose bodies composed of cartilage or cartilage and bone in joints, study of; with special reference to their pathology and etiology - - - - - - - 493
— — in joints in acute arthritis due to infection - - - - - - - - 494, 499
— — — changes in joint from long-continued presence of - - - - - - 515
— — — 'classical' type - - - - - - 502
— — — — — deductions upon behaviour of bone-corpuscles in autogenous graft to be drawn from study of - - - 520
— — — deductions as to etiology from experimental observations - - - - 518
— — — derived from interarticular fibrocartilages - - - - - 494, 510
— — — detached epi-articular ecchondroses 494, 496
— — — — osteophytes - - - - - 494
— — — diagnosis - - - - - - - 521
— — — exhibiting feeble proliferation of articular cartilage - - - - 509
— — — — formation of new bone from osteogenetic tissue in cancellous spaces accompanying the formation of secondary adhesions, or incomplete detachment - - 509
— — — — marked degree of proliferation of articular cartilage - - 506
— — — etiology and pathological deductions 516
— — — formed by detached epiphyses not forming portions of an articulating area - - - - - - - 494, 510
— — — — — portion of articular surface in normal joints - 494, 499, 500
— — — historical summary - - - - 493
— — — occurring with some general pathological process affecting joint - 494
— — — in osteo-arthritis - - - - - 494
— — — pathology and symptomatology - 494
— — — recent detachments - - - - 500
— — — synovial chondromata, diffuse 494, 511, 514
— — — — — laminated and non-laminated 494, 511
— — — — — multiple, pedunculated, free, or in combination 494, 511, 512
— — — — — single, pedunculated or free 494, 511
— — — in tabes - - - - - - - 494, 498
— — — traumatic factor in - - - - 517
— — — treatment - - - - - - - 522
— — — in tuberculous disease accompanied by necrotic caries - - 494, 498
Loreta's operation for congenital pyloric stenosis - - - - - - - - 399
Lupoid type of Baghdad boil - - - - - 260
Lymphangioma, treatment by radiation - 78
Lymphatic vessels between tongue and glands, removal in cancer - - - - - - 85
Lymphatics of the tongue: with particular reference to removal of lymphatic glands in cancer of the tongue - - 80
Lymphosarcoma, treatment by radiation in preference to surgery - - - 70, 71

PAGE

McCARTNEY, J. E., and FRASER, JOHN: Case of persistent vitelline artery: fatal intra-abdominal hæmorrhage from rupture of vessel - - - - - - 478
Mace, presentation of, to American College of Surgeons by consulting surgeons of British armies - - - - - - 237
McGREGOR, A. N.: Trap-door operation for empyema - - - - - - - 64
Madagascar, appendicitis in - - - - - 177
MAKINS, SIR G. H.: Specimens showing the effects of gunshot injury of the heart and blood-vessels - - - - - - 107
Male genital organs, radium treatment of malignant disease of - - - 36, 38, 39
Malignant and benign changes in duct epithelium of breast - - - - - - 285
— disease (*see also* Cancer; Tumours)
— — of bladder and male genital organs, radium treatment of - - - - 36
— goitre (*see* Goitre)
MARNOCH, JOHN: Case of gastrojejunocolic fistula with stercoraceous vomiting following gastro-enterostomy - - - - 368
Martin's method of closing bone cavities - - 460
MARXER, O. A.: Radiographs illustrating duodenal diverticula - - - - 18
Mastitis, long-standing, massive cholesterin deposits in breast in cases of - - 59
MAYLARD, A. ERNEST: Sex and age incidence in appendicitis - - - - - 189
Meat in relation to appendicitis - - - 180
Meckel's diverticulum, inflammation of, simulating acute appendicitis - - - 136
Medical education, lack of, in education of sixteenth century surgeon - - - 256
Meningitis in gunshot wounds of spinal cord - 214
Meningococcus septicæmia, case of - - - 198
Menstruation in relation to appendicitis - 186
Metacarpophalangeal joints, stiff, without gross bony alteration, treatment of - - 272
Morocco, appendicitis in - - - - - 176
Morphine before operations - - - - - 34
MORSON, CLIFFORD: Rôle of radium in treatment of malignant disease of bladder and male genital organs - - - - 36
MOYNIHAN, SIR BERKELEY G. A.: The ritual of a surgical operation - - - - - 27
— — — The surgery of the spleen - - 307
Muscle flaps to close septic bone cavities following gunshot wounds (*see also* Bone Cavities, Septic) - - - - - - 460
Muscular weakness in splenic disease - - 330

NÆVI - - - - - - - - 77, 79, 481
Nasal sinusitis in relation to appendicitis 183
Neck, aneurysms in - - - - - - 167
Nephritis, chronic, in pernicious anæmia - 336
Nerve, abnormal ulnar, in forearm, section of - 139
— manifestations in pernicious anæmia - 336
— recurrent laryngeal, paralysis of, a complication of goitre operations - - - 448
New Guinea, appendicitis in - - - - 177
NICHOLSON, G. W.: Carcinoma of the breast - 527
NICORY, C., and SHATTOCK, PROF. S. G.: Capillary angeiomatosis of the parotid gland (partial excision) - - - - 481
Nipple possibly portal of entry into breast of cancer-producing agent - - 163, 285
Norway, appendicitis in - - - - - 175
Nyassaland, appendicitis in - - - - 176

OBSTRUCTION, acute, of appendix, caused by carcinoma - - - - - 392
— intestinal, due to enterolith - - - 378
OLLERENSHAW, ROBERT: Development of cysts in connection with external semilunar cartilage of knee-joint - - - 409
Omnopon before operations - - - - 34
Omphalitis - - - - - - - - - 6
Omphalomesenteric cyst causing intussusception 228
Operation(s), abdominal, quinine and urea injections in - - - - - - 34
— Babcock's, for varicose veins (*see* Babcock's Operation) - - - - - - 486
— disinfection of skin in - - - - - 31
— gloves in - - - - - - - - 30
— purgation and starvation previous to - 28
— Rammstedt's (*see* Pylorus; Rammstedt's Operation)
— the ritual of a surgical - - - - - 27
— team work in - - - - - - - 35
— trap-door, for empyema - - - - - 64
— Trendelenburg's, for varicose veins - - 486
— use of morphine and other alkaloids before 34
Operative procedure suggested for repair of collateral ligaments of knee-joint 266, 267
Oriental sore (*see* Baghdad Boil)
Osteo-arthritis, loose bodies in joints in - - 494
Osteophytes, detached, forming loose bodies in joints - - - - - - - 494
Ovarian cyst diagnosed as new growth of colon 371
— — simulated by cystic dilatation of cæcum 452
Oxyuris in relation to appendicitis - - - 186

PAIN due to complete disruption of brachial plexus, division of posterior spinal roots for relief of - - - - - 142
— and discomfort due to tumour, radium and *x*-ray treatment for relief of - - 70
— in stumps - - - - - - - - 89
Pancreas, relation of spleen to - - - - 324
Pancreatitis, acute, and gall-stones simulating perforated gastric ulcer - - - 370
PANNETT, C. A.: An experimental investigation of the results of linear division of the pyloric sphincter - - - - - - 262
Papilliferous goitre (*see* Goitre)
Papilloma, benign, of breast ducts - - - 289
— of bladder of unusual size - - - - 374
— treatment by radiation - - - - 78
Paraffin method of closing bone cavities - 460
Paraguay, appendicitis in - - - - - 187
Paralysis of recurrent laryngeal nerve a complication of goitre operations - - 448
Paraplegia, case of, in which the second cervical vertebra was removed; with note of patient's condition 17 years later - 530
Parathyroid glands in goitre operations - - 451
Parotid gland, capillary angeiomatosis of - 481
— — time of establishment of ptyalogenous function of - - - - - - 481
Patella, downward dislocation of - - - 524
Pathology of gunshot wounds of spinal cord (*see* Spinal Cord)
— teaching in 16th century - - - - 250
Patient, the factor of, in regional anæsthesia - 279
Penis, malignant growths of, radium treatment 39
Perforated gastric ulcer simulated by gall-stones and acute pancreatitis - - 370
Perforation of intestine due to diverticulitis - 103
— ureter by calculus: extravasation of urine: death from uræmia and sepsis - 372
Pericardium and heart, specimens showing the effects of gunshot injuries to - - - 107
Peritonitis as a complication after Rammstedt's operation - - - - - 404
— general, caused by sloughing fibroid of uterus which ruptured into peritoneum 141
Pernicious anæmia, achlorhydria in - - - 336
— — diagram showing chief changes in - 333

PAGE
Pernicious anæmia, diarrhœa and vomiting in - 336
— — general account of - - - - - 332
— — hypertension (chronic nephritis) in - 336
— — nerve manifestations in - - - - 336
— — pigmentation in - - - - - 336
— — in relation to the spleen - - - 332
— — splenectomy in - - - - - 336
— — tongue in - - - - - - - 336
Persia, appendicitis in - - - - - - 176
Persistent vitelline artery: fatal intra-abdominal hæmorrhage from rupture of vessel - - - - - - - 478
— — — method of development - - - 479
Petechial hæmorrhages in splenic disease - 329
PHILLIPS, JAMES: Two cases of intestinal obstruction due to an enterolith: with reports of the chemical analysis - - 378
Physiology and anatomy of spleen - - - 313
Pigmentation of intestinal mucous membrane in cystic dilatation of cæcum and intestinal stasis - - - - - 456–9
— in pernicious anæmia - - - - - 336
Pituitary body, influence of - - - - - 9
Plaster-of-Paris in treatment of stiff meta-carpophalangeal joints - - - - - 272
PLATT, HARRY: Traumatic dislocation of the knee-joint - - - - - - - - 190
Plethysmographic methods in deciding question of operation for varicose veins - - 488
Pleural adhesions found at autopsy in cases of early fatality seen at a casualty clearing station - - - - - - 195
Polynesia, appendicitis in - - - - - 177
Position of patient in Babcock's operation for varicose veins - - - - - - 487
— — in laminectomy - - - - - - 475
Posterior spinal roots, division for relief of pain due to complete disruption of brachial plexus - - - - - - - - 142
POWER, SIR D'ARCY: The education of a surgeon under Thomas Vicary - - 240
Presentation of Great Mace to American College of Surgeons by consulting surgeons of British armies - - - 237
'Presentation of patients in peril of death or maim' - - - - - - - - 253
Preservatives, food, in relation to appendicitis 184
Primary duct cancer of breast - - - 291
PRINGLE, J. HOGARTH: Case of paraplegia in which the second cervical vertebra was removed; with note of patient's condition 17 years later - - - 530
Prostate, malignant growths of, treatment by radium - - - - - - - - 38
Psoriaform type of Baghdad boil - - - 260
Ptyalogenous function of parotid gland, time of establishment - - - - - 481
Public, education of, in 16th century to appreciate surgery - - - - - - 253
Purgation and starvation before operations - 28
Purpura hæmorrhagica and the spleen - - 331
Pyæmia due to *Staphylococcus aureus* - - 199
PYBUS, F. C.: Severe intestinal hæmorrhage following appendectomy - - - 534
Pyloric sphincter, experimental investigation of results of linear division - - - 262
Pylorus, congenital stenosis, medical treatment 398
— — — pathology - - - - - 397
— — — surgical treatment - - - - 399
— — — — — gastro-enterostomy - - 399
— — — — — Loreta's operation - - 399
— — — — — pyloroplasty - - - - 399
— — — — — Rammstedt's operation (*see also* Rammstedt's Operation) 397
— — — — — resection of pylorus - - 399
— — — — — Russell Coombe's extramucous division - - - - - 400
PAGE
Pylorus, congenital stenosis, surgical treatment, Weber's extramucous pyloroplasty - 399
— resection of, for congenital stenosis - - 399
Pyrexia in splenic disease - - - - - 330

QUACKERY in 16th century - - - - 253
Quinine and urea injections in abdominal operations - - - - - - - - 34

RADIUM, effect upon normal tissues - 36
— irradiation in relation to sepsis in treatment of malignant disease - 36
— treatment of hæmolytic jaundice - - 356
— — leukæmia - - - - - - - - 343
— — malignant disease of bladder and male genital organs - - - - - - 36
— and *x*-ray treatment of tumours - - 68
— — — — action of radiations - - 68, 77
— — — — after-effects - - - - - 76
— — — — — irradiation sickness - - 76
— — — — — late irradiation effects - - 77
— — — — — surface effects - - - 77
— — — — benign - - - - - - 77
— — — — — angioma - - - - 77, 79
— — — — — fibromyoma of the uterus 78, 79
— — — — — goitre - - - - - - 78
— — — — — keloid - - - - - - 78
— — — — — lymphangioma - - - 78
— — — — — papillomata, warts, and corns 78
— — — — forms of tumour for which radiations should be used 70, 77
— — — — harmful effects of radiations - - 69
— — — — indications as to when and by what method radiation should be used 74, 78
— — — — for the purpose of destruction of growth - - - - - - 70
— — — — — prevention of inoculation of tumour cells into a wound - 69
— — — — — relief of pain and discomfort - 70
— — — — — rendering inoperable growths operable - - - - - 70
— — — — type of radiation to be used 72, 77
Rammstedt's operation (*see also* Pylorus)
— — after-treatment - - - - - - 403
— — anæsthesia - - - - - - - 400
— — anatomical results - - - - - 402
— — in cats, results of - - - - - 262
— — complications following - - - 403
— — — — diarrhœa - - - - - - 404
— — — — fever - - - - - - - 405
— — — — hæmorrhage - - - - - 403
— — — — peritonitis - - - - - 404
— — — — recurrence of symptoms - - 406
— — — — shock - - - - - - 403
— — details of ten cases - - - - - 407
— — history - - - - - - - - 400
— — preparation for operation - - - 400
— — technique - - - - - - - 400
— — in treatment of congenital pyloric stenosis - - - - - 397, 400
RAMSAY, ROBERT A.: Treatment of congenital hypertrophic stenosis of pylorus by Rammstedt's operation - - - - - 397
Rare or Obscure Cases:—
Cholelithiasis: notes on a case with a calcified gall-bladder - - - - - 533
Congenital abnormality of female genito-urinary organs - - - - - - 377
Division of posterior spinal roots for relief of pain due to complete disruption of brachial plexus - - - - - - 142
Gunshot wound of forearm masking symptoms of cervical rib - - - - - 226
Intestinal obstruction due to an enterolith: with reports of the chemical analysis - 378

PAGE

Rare or Obscure Cases, *continued*:—
Intussusception of the vermiform appendix 227
Ligature of the hepatic artery - - - 532
Omphalomesenteric cyst causing intussusception - - - - - - - 228
Papilloma of bladder of unusual size - 374
Paraplegia in which the second cervical vertebra was removed; with note of patient's condition 17 years later - 530
Perforation of ureter by calculus: extravasation of urine: death from uræmia and sepsis - - - - - - - 372
Section of abnormal ulnar nerve in forearm 139
Severe intestinal hæmorrhage following appendectomy - - - - - - 534
Sloughing fibroid of uterus which ruptured through fundus into peritoneal cavity, causing general peritonitis: laparotomy: complete hysterectomy - - - 141
Tonsillar calculus of unusual size - - 375
Transposition of viscera associated with gall-stones and hour-glass stomach - 137
Re-amputation, technique of - - - - 88, 92
Recurrent laryngeal nerve paralysis a complication of goitre operations - - - 448
Regional anæsthesia in abdominal surgery - 278
— — — — the anæsthetic - - - - 279
— — — — the anæsthetist - - - 279
— — — — the method - - - - 279
— — — — the patient - - - - 279
— — — — the results - - - - 283
— — — — the surgeon and his assistants - 280
— — — — the technique - - - - 280
— — with special reference to 'splanchnic analgesia' - - - - - 278
Repair of collateral ligaments of knee-joint - 266
Resection of pylorus for congenital stenosis - 399
Reticulo-endothelial system, disorders of - 346
— — the spleen as part of - - - - 321
Retroclavicular and retrosternal goitre - - 434
Reviews and Notices of Books:—
The after-treatment of surgical patients (Bartlett and others) - - - - 383
Amputaciones cineplasticas (Arana) - - 232
Anæsthetics: their uses and administration (Buxton) - - - - - - 387
An atlas of the primary and cutaneous lesions of acquired syphilis in the male (White and Brown; foreword by Goodwin) - - - - - - - 144
Backwaters of Lethe; some anæsthetic notions (Barton) - - - - - 144
Chirurgie réparatrice et orthopédique (Jeanbrau, Nové-Josserand, Ombrédanne and Desfosses) - - - - - - - 382
Chirurgische Anatomie und Operationstechnik des Zentralnervensystems (Tandler and Ranzi) - - - - - - - 537
Collected papers of the Mayo clinic, 1918, vol. x (ed. Mellish) - - - - 535
The course of operative surgery (Schmieden, transl. by Turnbull; foreword by Bier) 235
Diagnosis and treatment of brain injuries (Sharpe) - - - - - - - 384
Diathermy in medical and surgical practice (Saberton) - - - - - - 233
Die deutsche Chirurgie im Weltkrieg, 1914–1918 (Borchard and Schmieden) - - 235
Diseases of the nose, throat, and ear (Syme) 384
Diseases of the rectum (Hirschman) - - 230
The early history of surgery in Great Britain: its organization and development (Parker) - - - - - - 380
Fractured femurs: their treatment by calliper extension (Pearson and Drummond; foreword by Gray) - - - - 234
Gonococcal infection in the male (Lumb) - 386

PAGE

Reviews and Notices of Books, *continued*:
Industrial medicine and surgery (Mock) - 385
Injuries of the peripheral nerves (Souttar and Twining) - - - - - - 382
Lippincott's quick reference book for medicine and surgery (Rehberger) - - - 536
A manual of war surgery (Barling and Morrison)
Manuel d'urétroscopie (Henri and Demonchy; preface by Marion) - - - - - 387
Massage: its principles and practice (Mennell) - - - - - - - 388
Modern surgery (Da Costa) - - - - 388
Orthopædic and reconstructive surgery, industrial and civilian (Albee) - - 381
Plastic surgery of the face: based on selected cases of war injuries of the face, including burns (Gillies, Fry, Wade) - - - - 232
Privy Council Medical Research Council: first report of the committee upon injuries of the nervous system - - - - 535
Selected lectures and essays (Bland-Sutton) 230
Surgery (*Student's Synopsis Series*) (Back and Edwards) - - - - - - 537
Surgery, a text-book by various authors (Gask and Wilson) - - - - - 380
Surgical pathology and morbid anatomy (Bowlby and Andrewes) - - - 536
Surgical shock and the shockless operation through anoci-association (Crile and Lower) - - - - - - - - 231
Surgical therapeutics and operative technique (Doyen; English ed. in collaboration with Brown) - - - - - - 235
Surgical treatment: a practical treatise on the therapy of surgical diseases; for the practitioners and students of surgery (Warbasse) - - - - - - 233
Synopsis of surgery (Groves) - - - - 537
Tumours complicating pregnancy, labour, and the puerperium (Spencer) - - - 383
Venereal diseases: their clinical aspect and treatment (McDonagh) - - - - 385
Rib, cervical, symptoms masked by gunshot wound of forearm - - - - - 226
Ribs, cervical, or cerebral syphilis—question of responsibility for symptoms in case presenting both - - - - - - - 529
Ritual of a surgical operation - - - - 27
Roots, nerve, posterior spinal, division for relief of pain due to complete disruption of brachial plexus - - - - - - - 142
Roumania, appendicitis in - - - - - 176
RUTHERFURD, H.: Downward dislocation of patella - - - - - - - - 524

SALAMANDER and axolotl, effect of thyroid feeding - - - - - - 9
Salivary glands, capillary angeiomatosis of - 482
Schede's aseptic blood-clot method of closing bone cavities - - - - - - 460
Schultzen and the closing of bone cavities 460–70 *passim*
Science and surgery—inaugural address, Association of Surgeons of Great Britain and Ireland - - - - - - - - 6
Scopolamine before operations - - - 34
Section of abnormal ulnar nerve in forearm - 139
Selenium, preparations of - - - - - 50
— properties of - - - - - - - 50
— treatment of inoperable cancer - - - 50
— — — — contra-indications - - - 53
— — — — effects - - - - - 52
— — — — illustrative cases - - - - 56
— — — — indications - - - - 52
— — — — mode of action - - - 54

PAGE
Selenium treatment of inoperable cancer, results 53
— — — — technique 51
Semilunar cartilage, external, of knee, development of cysts in connection with 409
Senn's decalcified bone-chip method of closing bone cavities 460
Sepsis in relation to radium irradiation for malignant disease 36
Septic bone cavities following gunshot wounds, closure by muscle flaps (*see also* Bone Cavities, Septic) 460
— hæmothorax 193
Septicæmia, meningococcic, case of 198
Sex and age incidence in appendicitis 189
— — — in series of 500 goitre operations 413
SHATTOCK, PROF. S. G., and NICORY, C.: Capillary angeiomatosis of the parotid gland 481
Shock as a post-operative complication after Rammstedt's operation 403
SHORT, A. RENDLE: The causation of appendicitis 171
Shoulder, flail, successful treatment of case of 133
Sickness due to irradiation 76
Sinuses, old discharging, following gunshot wounds of bone, treatment by muscle flaps (*see also* Bone Cavities, Septic) 460
Sinusitis, nasal, in relation to appendicitis 183
Sixteenth century education of public to appreciate surgery 253
— — — of a surgeon 240
— — — — lack of medical education 256
— — quackery in 253
— — surgical consultation in 253
Skin disinfection 31
Sloughing fibroid of uterus which ruptured into peritoneum and caused general peritonitis 141
SMITH, R. ECCLES: Ligature of the hepatic artery 532
Solomon Islands, appendicitis in 177
Sore, tropical (*see* Baghdad Boil)
Spain, appendicitis in 175
Specimens from the R.C.S. Museum showing the effects of gunshot injury of the heart and blood-vessels 107
SPENCER, F. M.: A case of ascites due to a chronic intussusception of several months' duration 366
SPENCER, W. G.: Intestinal stasis followed by cystic dilatation of cæcum, without intestinal obstruction 452
Spermatic cord, acute encysted hydrocele of 40
Sphincter, pyloric, experimental investigation into results of linear division 262
Spinal cord, pathology of gunshot wounds of 202
— — — — contusion by direct impact or tangential wound 209
— — — — fragments lodged within spinal canal 202
— — — — hæmorrhage 213, 218
— — — — meningitis 214
— — — — transfixion of contents of spinal canal by missile 206
— nerve-roots, posterior, division for relief of pain due to complete disruption of brachial plexus 142
'Splanchnic analgesia' (*see also* Regional Anæsthesia) 278, 283
Spleen, anatomy and physiology of 313
— defensive properties against infection 322
— functions of 313
— and the hæmorrhagic diathesis 331
— influence on activation of digestive ferments 319
— — formation of bile-pigment 318
— as a member of the digestive system 323
— — hæmopoietic system 320
— as part of the reticulo-endothelial system 321
PAGE
Spleen as part of sympathico-endocrine system 325
— relation to destruction of red cells 317, 318
— — liver 324
— — pancreas 324
— — small intestine 325
— secretion of ferment, etc., by 318, 319
— surgery of 307
— — history 307
— — in relation to hæmolytic jaundice (*see* Hæmolytic Jaundice)
— — — Hodgkin's disease (*see* Hodgkin's disease)
— — — leukæmia (*see* Leukæmia)
— — — pernicious anæmia (*see* Pernicious Anæmia)
— — — splenic anæmia and Banti's disease (*see* Banti's disease)
Splenectomy in Banti's disease 352
— changes in the blood and other cells after 317
— in hæmolytic jaundice 356
— Hodgkin's disease 347
— leukæmia 343, 344
— pernicious anæmia 336
Splenic anæmia (*see* Banti's Disease)
— disease, anæmia in 327
— — clinical and associated phenomena in 327
— — differential diagnosis 357, 358
— — jaundice in 329
— — leucocytosis in 330
— — muscular weakness in 330
— — pathology of 326
— — petechial hæmorrhages in 329
— — pyrexia in 330
— — splenomegaly in 330
— — and urobilinuria 331
— vein, chronic obstruction of, diagnosis from Banti's disease 351
'Splenogenic thrombolytic purpura' 331
Splenomegaly in splenic disease 330
Spoon used in operations for intrathoracic goitre 437
SPRIGGS, EDMUND I.: Duodenal diverticula 18
Staphylococcus aureus pyæmia 199
Starvation and purgation before operations 28
Stasis, intestinal (*see also* Intestinal Stasis)
— — in relation to appendicitis 186
Stenosis of bowel due to diverticulitis 98
— pylorus, congenital (*see* Pylorus; Rammstedt's Operation)
Stercoraceous vomiting with gastrojejunocolic fistula following gastro-enterostomy 368
Sterilization of skin 31
STEWART, M. J., and FORSYTH, J. A. C.: On the occurrence of massive cholesterin deposits in the breast in cases of long-standing mastitis 59
Stiff metacarpophalangeal joints without gross bony alteration, treatment of 272
Stomach, hour-glass, and gall-stones associated with transposition of viscera 137
Stumps, amputation, desiderata in 88
— — pain in 89
— — technique of re-amputation 88, 92
Submaxillary gland, angeiomatosis of 482
Surgeon, education of, in 16th century 240
— — — — lack of medical education 256
— — under Thomas Vicary 240
— and his assistants in regional anæsthesia, rôle of 280
Surgeons of Great Britain and Ireland, Association of 1
— — — — — inaugural address 6
Surgery, abdominal, regional anæsthesia in (*see* Regional Anæsthesia)
— education of public in 16th century to appreciate 253
— lamps and specialism in 17
— in relation to embryology 16

PAGE

Surgery, science and - - - - - - 6
— of spleen (*see* Spleen, Surgery of)
— teaching in 16th century - - - - 250
Surgical Clinics at Home and Abroad:—
Mr. James Berry's clinic at the Royal Free Hospital - - - - - - - 361
Prof. Henri Hartmann at the Hôtel Dieu, Paris - - - - - - - 223
Clinic of Sir Robert Jones at Liverpool - 42
Sir Arbuthnot Lane at Guy's Hospital - 219
Sir William Thorburn's clinic at Manchester 473
Surgical education in 16th century - - 240, 245
— — — — lack of medical education - - 256
— operation, the ritual of - - - - - 27
Sutures and ligatures, material used for - - 33
Sweden, appendicitis in - - - - - 175
Sympathico-endocrine system, relation of spleen 325
Synovial chondromata forming loose bodies in joints (*see* Loose Bodies in Joints)
Syphilis, cerebral, or cervical ribs: question of responsibility for symptoms in case presenting both - - - - - - 529
Syphilitic enlargement of spleen and liver, diagnosis from Banti's disease - - - 350
Syphiloid type of Baghdad boil - - - 260

TABES, loose bodies in joints in - 494, 498
TALBOT, PHILIP: Cholelithiasis: notes on a case with a calcified gall-bladder 533
Tartar emetic in Baghdad boil - - - 261
Team work in operations - - - - - 35
Technique of re-amputation - - - 88, 92
Teeth, carious, in relation to appendicitis - 183
Test to differentiate between tendon-shortening and fibrosis - - - - - - 272
Testicle, malignant growths of, radium in - 39
Testicles and feathers of birds, relationship - 13
— of sparrow, seasonal changes in - - - 12
Tetany, a complication of goitre operations - 451
THOMAS, HUGH OWEN, chair used by, for reduction of old dislocations of shoulder - 42
THORBURN, SIR WILLIAM, clinic at Manchester - 473
— — Pathology of gunshot wounds of the spinal cord - - - - - - 202
'Thrombo-cytolytic syndrome' - - - - 331
Thyroid gland, influence of - - - - - 8
— — insufficiency of, a complication of goitre operations - - - - - - 450
— — surgery of (*see also* Goitre) - - 362, 413
'Thyrotoxic' adenoma - - - - - 432
Tibial collateral ligament, repair of - - 269
TODD, ALAN H.: On the technique of re-amputation - - - - - - - - 88
Tongue, cancer of, removal of lymphatics in 80, 83, 85
— lymphatics of: with particular reference to removal of lymphatic glands in cancer 80
— in pernicious anæmia - - - - - 336
Tonsillar calculus of unusual size - - - 375
Tortuosity of varicose veins - - - - 489
Tracheotomy in suffocating goitre - - - 425
Transposition of viscera associated with gall-stones and hour-glass stomach - - 137
Trap-door operation for empyema - - - 64
Trauma in relation to appendicitis - - - 186
Traumatic aneurysms due to gunshot injuries 126
— dislocation of knee-joint - - - - 190
Trendelenburg's operation for varicose veins - 486
Trolley, bed, in use in Sir W. Thorburn's clinic at Manchester - - - - - - 474
Tropical sore (*see* Baghdad boil)
Tuberculous disease accompanied by necrotic caries, loose bodies in joints in - 494, 498
Tumours (*see also* Cancer; Malignant Disease)
— in relation to embryology - - - - 16
— treatment by radium and *x* rays (*see* Radium and *X*-ray Treatment of Tumours)

PAGE

ULCER, gastric or duodenal, diagnosis from Banti's disease - - - - - - 350
— — perforated, simulation by gall-stones and acute pancreatitis - - - - 370
Ulcerating type of Baghdad boil - - - 260
Ulnar nerve, abnormal, in forearm, section of - 139
ULRICH, MAJOR F. F. A.: Flail shoulder - - 133
Umbilical cord, ligature of - - - - - 6
United States, appendicitis in - - - - 176
Ureter, perforation of, by calculus: extravasation of urine: death from uræmia and sepsis - - - - - - - 372
Urine, extravasation of, with death from uræmia and sepsis, resulting from perforation of ureter by calculus - - 372
Urobilinuria and splenic disease - - - 331
Uterus, sloughing fibroid of, which ruptured into peritoneum and caused general peritonitis - - - - - - - 141

VARICOSE veins, Babcock's extraction operation for (*see also* Babcock's Operation) - 486
— — impulse a test for incompetency of the valves - - - - - - - 489
— — plethysmographic methods in deciding question of operation - - - 488
— — prospect held out by operative interference - - - - - - - 489
— — symptoms and signs of - - - 488
— — Trendelenburg's operation for - - 486
Vertebra, second cervical, removed for paraplegia; with note of patient's condition 17 years later - - - - - - 530
Vesicocolic fistula due to diverticulitis - - 105
VICARY, THOMAS, education of a surgeon under (second Vicary Historical Lecture) - 240
Viscera, transposition of, associated with gall-stones and hour-glass stomach - - 137
Vitelline artery, persistent: fatal intra-abdominal hæmorrhage from rupture of vessel - - - - - - - 478
— — — method of development - - - 479
Vomiting and diarrhœa in pernicious anæmia 336
— stercoraceous, with gastrojejunocolic fistula following gastro-enterostomy - - 368

WAKLEY, C. P. G.: Gunshot wound of forearm masking symptoms of cervical rib 226
War collection of pathological specimens in R.C.S. museum: heart and blood-vessels 107
— — — — — — spinal cord - - - 202
Warts, treatment by radiation - - - - 78
WATSON-WILLIAMS, E.: Treatment of inoperable cancer with selenium - - - - 50
Weber's extramucous pyloroplasty for congenital pyloric stenosis - - - - 399
West Indies, appendicitis in - - - - - 176
WILKIE, D. P. D.: Carcinoma of appendix causing diverticula of appendix and acute appendicular obstruction - - 392
WOOD, DUNCAN: Closure of septic bone cavities following gunshot wounds by muscle flaps - - - - - - - 460
WOODMAN, G. S.: Tonsillar calculus of unusual size - - - - - - - - - 375

X-RAY determination of site of compression in dyspnœa due to goitre - - - - 426
— and radium treatment of tumours (*see* Radium and *X*-ray Treatment of Tumours)

ZANZIBAR, appendicitis in - - - - 177

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INDEX TO ADVERTISEMENTS.

Anæsthetics.

	PAGE
Kerfoot's Kerocain	iii
Saccharin Corporation Ltd.	xiii

Chemical Preparations.

Kerfoot, Thos., & Co. Ltd.	iii
Matthews, Harold E. & Co.	xix
Zimmermann, Chas. & Co. (Chem.) Ltd. ...	xiii

Dietetic Articles.

Fry's Malted Cocoa	xviii

Electro-Medical Apparatus.

Cox-Cavendish Electrical Co. Ltd.	xvi
Newton & Wright Ltd.	xx

Publishers and Periodicals.

Appleton, D. & Co.	vii
Bale, John, Sons & Danielsson Ltd.	iv
Churchill, J. & A.	i
Kimpton, Henry	vii
Lewis, H. K. & Co. Ltd.	iv
Livingstone, E. & S.	vi
Macmillan & Co. Ltd.	vi
Medical Annual, 1921	xi
Neurology and Psychopathology, Journal of ...	x
Oxford University Press	iv
Quarterly Journal of Medicine	iv
Saunders, W. B. Co. Ltd.	v
Wright, John & Sons Ltd. ...	vi, x, xi, xii, xiii, xiv

Surgical Instruments and Appliances.

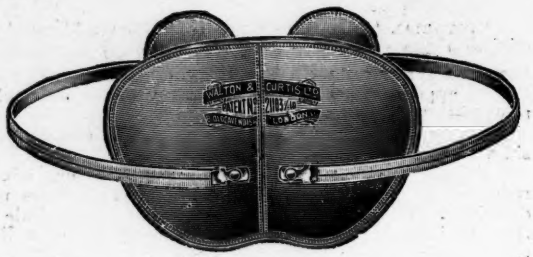
Allan & Hanburys Ltd.	*Front cover*
Bailey, W. H. & Son	xviii
Down Bros. Ltd.	*Back cover*
Gloucestershire Surgical Appliances Co. ...	viii
Hawksley & Sons	xviii
Holland, T. & Son	xiv
Kenney Limb Co. Ltd.	viii
McClean, A. E.	xv
Mayer & Phelps	ix
Merson, G. F. Ltd.	xiv
P. K. Arm Ltd.	xv
Robinson & Sons Ltd.	viii
Salmon Ody Ltd.	viii
Simplex Conduits Ltd.	xiv
Surgical Manufacturing Co. Ltd. ...	*Back cover*
Vickers Ltd.	xvii
Walton & Curtis Ltd.	ii

Wanted.

Back Numbers of this Journal	x

X-Ray Plates.

Elliott & Sons Ltd.	xviii
Kodak Ltd.	xx



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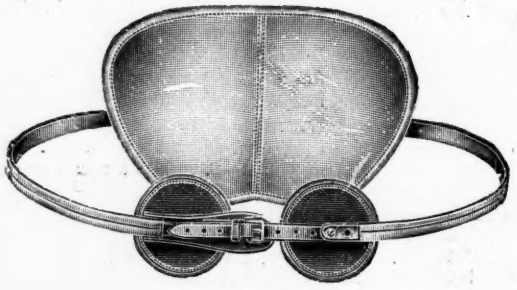

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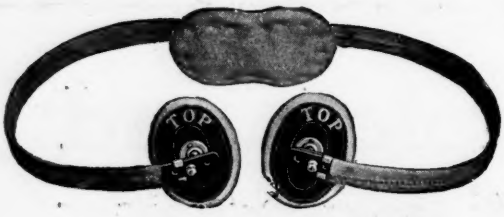

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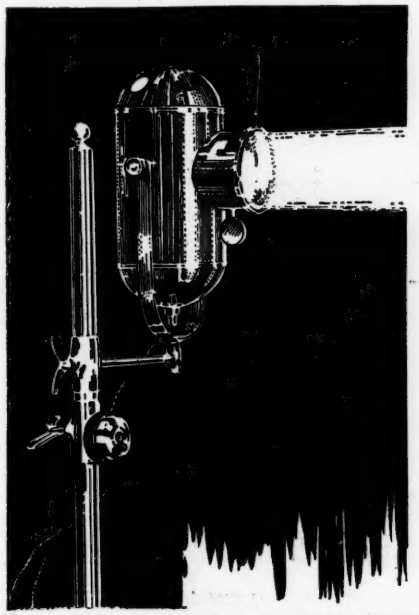

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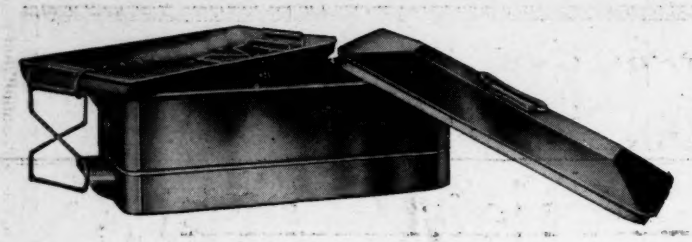

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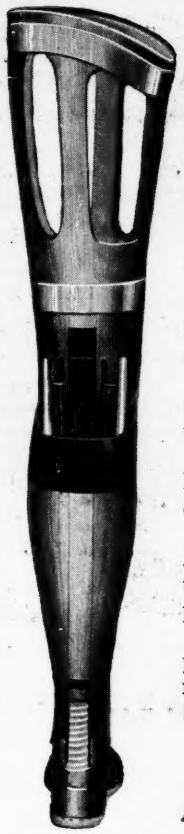

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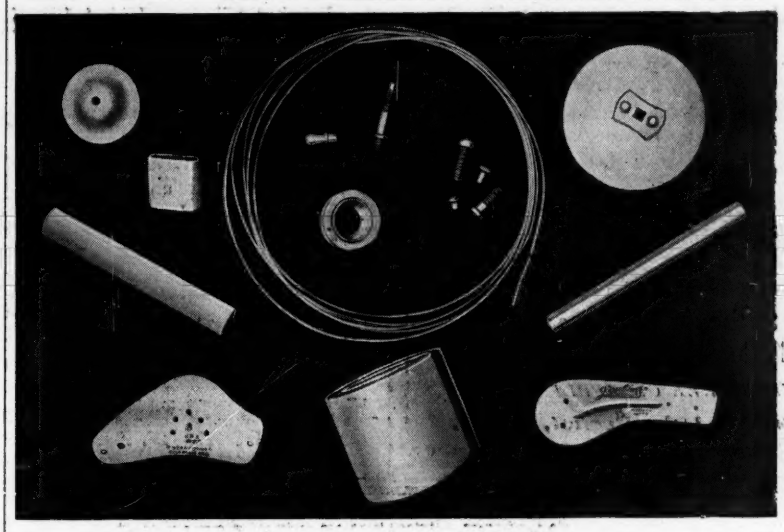

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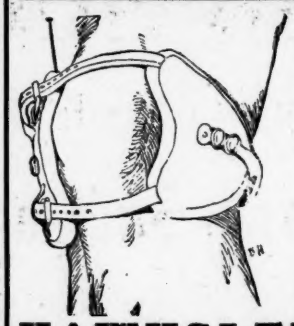

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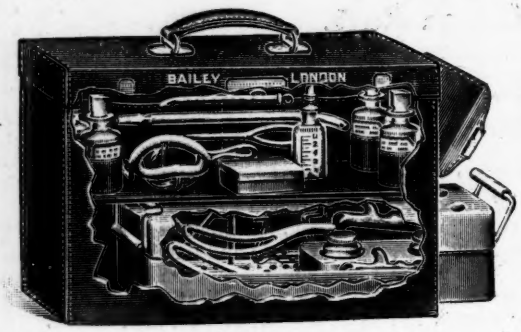

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